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Department of Defense

CASEBOOK
LIFE CYCLE COSTING
IN
EQUIPMENT PROCUREMENT

JULY 1970

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PREFACE

Life Cycle Costing (LCC) is an acquisition or procurement technique which considers operating, maintenance, and other costs of ownership as well as acquisition price, in the award of contracts for hardware and related support. The objective of ~~this~~ technique is to ensure that the hardware procured will result in the lowest overall ownership cost to the Government during the life of the hardware.

This Casebook describes and illustrates the application of life cycle costing to competitive procurements of equipments below the level of major systems. The cases are based upon actual procurements, although some have been modified in the interest of clarity and comprehension.

The Casebook is designed to be used as an aid in implementing the life cycle costing concept in equipment procurements within all DoD components. To facilitate this use, the reader should familiarize himself with the DoD Life Cycle Costing Procurement Guide, review the Introduction in this Casebook, note the elements and techniques which might be applicable to the equipment being procured, and then study the cases discussing those techniques and elements to determine the appropriate life cycle costing approach.

As experience is gained in implementing life cycle costing, this Casebook will be revised and supplemented as appropriate. Recommendations for this purpose should be forwarded through normal channels to the Co-Chairmen, DoD Life Cycle Costing Steering Group, OASD(I&L), Directorate for Procurement Management.

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BACKGROUND AND INTRODUCTION

Life Cycle Costing (LCC) has been accepted, conceptually, for over 20 years as being applicable to Department of Defense (DoD) procurement. The Armed Services Procurement Act of 1947 stated, in part, "Award shall be made....to the responsible bidder whose bid.. .will be most advantageous to the United States, price and other factors considered." (Underlining added.) The supporting report of the Senate Committee on the Armed Services confirmed that "other factors" included (among others) consideration of "ultimate cost." Nevertheless, award of contracts on the basis of acquisition price alone continued to be the predominant practice by an overwhelming proportion.

DoD management became increasingly concerned over some undesirable consequences of that practice and, in late 1963, the Assistant Secretary of Defense (Installations and Logistics) (ASD(I&L)) initiated a study of the effect that price competition may have on life cycle equipment costs. The initial effort was directed toward the award of production contracts for minor subsystems, assemblies, subassemblies, and parts.

Two recommendations of this study[1] were:

1. The practicability of evaluating logistics costs in procurement should be tested in actual procurements of non-commercial reparable equipments, and the guideline outlined (in that study) should be used in conducting such tests,

2. Award of contracts for nonreparable equipments on the basis of lowest price per unit of service life (mile,

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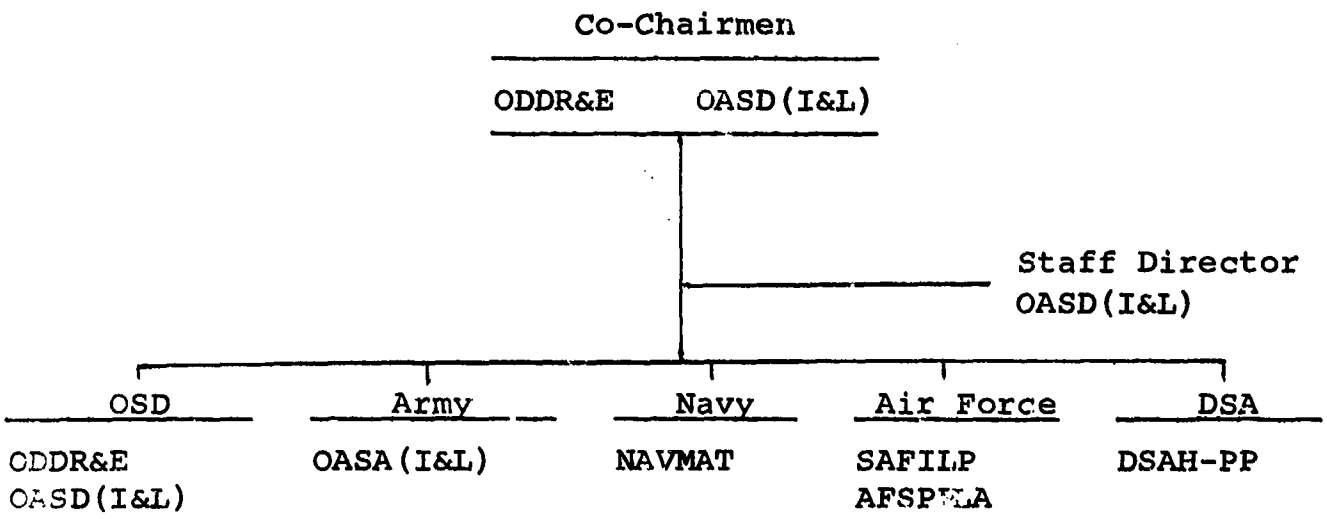
[1] Logistics Management Institute. Life Cycle Costing in Equipment Procurement. Task 4C-5, Washington, D.C. April 1965. Available from the Defense Documentation Center, AD #619871.

operating hour, calendar month, etc.) should be tested in actual procurements in which service life in excess of the minimum required is useful.

On 10 July 1965, the ASD(I&L) issued a memorandum to the Assistant Secretaries (I&L) of the Military Departments which stated, in part,

> "It is proposed that a Steering Group shall be established composed of representatives of my office....and at least one representative from each Military Department. Additionally, each Department will establish Life Cycle Costing Task Groups...."

The Steering Group later was expanded to include the Office of the Director of Defense Research and Engineering (ODDR&E) and the Defense Supply Agency (DSA). Increased recognition of the importance of the role of engineering personnel led to the decision to have ODDR&E share in direction of the Group (4 June 1966). The present organizational structure of the Steering Group is:



On 1 April 1967, a memorandum from the ASD(I&L) and the DDR&E to the Assistant Secretaries of R&D and I&L of the Military Departments and the Director, DSA noted the need for special emphasis in 10 specific areas. The memorandum noted, in part,

> "In the past year and a half, under the leadership of the DoD Steering Group on Life Cycle Costing, efforts have been made to implement this concept in materiel acquisitions. The results to date have been gratifying. Our experience indicates however that our progress can be accelerated by redirecting our effort to certain specific problems that have been identified. .....
> .....
> Toward this end, attached is a list of problem areas and tasks on which attention should be concentrated to achieve increased implementation of life cycle costing."

The memorandum specified the problem areas as:

1. Reliability Predictions
2. Maintainability Predictions
3. Maintenance Costs
4. Verification/Demonstration
5. Supply Management
6. Training
7. Operating Costs
8. Service Life
9. Equipment Selection (for LCC application)
10. Contractual Provisions

Task Groups were established in all areas by each Military Department. In some areas, DSA established Task Groups. When those groups started to produce draft reports, Interdepartment Task Groups were organized (14 December 1967).

At the request of the Steering Group, the National Security Industrial Association has cooperated in the LCC area by providing review and commentary through a Life Cycle Costing Task Group with sub-groups paralleling the DoD Task Groups. The interest on industry's part is a natural one since any change in DoD procurement practices would affect a substantial number of corporations. Industry's interest is desirable from DoD's standpoint because the private sector has been using LCC techniques for many years and should be able to facilitate DoD's use of the LCC concept. The DoD-Industry interface on LCC is continuing.

In reviewing existing LCC reports and interim Task Group reports, the Steering Group concluded that general guidance in the identified problem areas might not be sufficient to bring about widespread LCC application. Detailed and specific examples in the form of realistic case descriptions were called for. This document is the result of a study to develop the needed examples.

Case material was sought and obtained from the Military Departments. Once tentative Case descriptions were drafted, the originating commands reviewed and commented on the cases. Comments also were received from the Steering Group.

Each Case covers a real procurement and may be read independently. In some Cases, only a few LCC elements were included because background data were not available at the time or the priority of the procurement was such that little effort could be spared to try out a new method. In other Cases, the actual

procurement used all of the applicable LCC elements. In some Cases, a few numbers have been changed to protect proprietary information. In other Cases, elements have been added to indicate how certain costs might be included in future procurements.

On 26 February 1969, DoD Instruction 7041.3, "Economic Analysis of Proposed Department of Defense Investments," was issued covering the discounting of future cash flows and the determination of present values of proposed investment alternatives. All of the procurements chosen for Case presentations were issued prior to the issuance of that directive. Therefore, they have been modified, primarily in the Bid Evaluation Sections, to include the calculation of Present Value as specified in DoDI 7041.3. In most Cases, the modification involved very minor additions or alterations to the stated evaluation, illustrating the ease with which Present Value can be included in LCC procurements.

All the military departments participated in the structuring of Cases. The techniques presented are applicable to all departments. No single Case, however, is offered as the only way to use LCC in procuring the equipment involved. No single Case approaches completeness in its depiction of LCC. The whole range of Cases is necessary for a general understanding. To that end, the selection of Cases was governed primarily by the wish to provide a broad spectrum of equipments, techniques, and cost elements.

LCC TECHNIQUES

The goals of the Case development study were to:

1. Cover a broad range of equipment types.
2. Select techniques and procedures for verifying companies' claims.
3. Devise appropriate penalties for failure to satisfy claims.
4. Identify significant logistic cost categories.
5. Select techniques for forecasting logistic costs.
6. Select cost factors supplied to the competing companies by the DoD.

Table A shows the coverage of Items 1 through 4.

Existing techniques and methods are sufficient and valid for application to LCC. Each Case includes accepted cost factors and engineering test methods. The existence of the Invitation For Bid (IFB), Request For Proposal (RFP), or contract in each Case attests to the ability of procurement personnel to incorporate those factors and methods in a legal document. Thus, the coverage of Items 5 and 6 and the depth of coverage of Items 2 and 3 may be observed only by reading the appended Cases.

As shown in Table A, equipment types include mechanical, electrical/electronic, and materials, services, and other. Both reparable and non-reparable items are included for each equipment type.

Rather than focusing on specific LCC forecasting and testing techniques which have been detailed adequately by the individual

Table A

SUMMARY OF EQUIPMENT TYPES, VERIFICATION TECHNIQUES, AND LCC ELEMENTS COVERED BY THE CASES

	Case 1 (Ship Engines)	Case 2 (House Siding)	Case 3 (Oscilloscopes)	Case 4 (Tach.-Generator)	Case 5 (Tires)	Case 6 (Traveling Wave Tube)	Case 7 (Computers)
EQUIPMENT							
Mechanical	X			X			X
Electrical/Electronic			X	X		X	X
Materials, Services & Other		X			X		X
Reparable	X	X	X				X
Non-reparable				X	X	X	
VERIFICATION TECHNIQUES							
Pre-Award Testing		X			X		X
Post-Award Testing	X		X	X	X	X	
Penalty Clause	X		X	X	X	X	
Bonded Warranty		X					
Contractor Maintenance							X
LCC ELEMENTS							
Initial							
Purchase Price	X	X	X	X	X	X	X
Delivery					X	X	X
Testing							
Installation		X		X	X	X	
Inventory Management	X		X				
Training	X						
Operation & Support							
Item Life (Factor)	X	X	X	X	X	X	X
Operating Labor							X
Materials & Utilities	X						
Training	X						X
Preventive Maintenance		X	X				X
Corrective Maintenance		X	X				
Inventory: Management	X		X				
Storage						X	

(Continued)

Table A
(Continued)

SUMMARY OF EQUIPMENT TYPES, VERIFICATION TECHNIQUES, AND LCC ELEMENTS COVERED BY THE CASES

	Case 1 (Ship Engines)	Case 2 (House Siding)	Case 3 (Oscilloscopes)	Case 4 (Tach.-Generator)	Case 5 (Tires)	Case 6 (Traveling Wave Tube)	Case 7 (Computers)
LCC ELEMENTS (cont'd)							
Final							
Dismantling							
Residual Value					X	X	

Commands, Departments, and OSD, the Cases highlight the roles of pre-award and post-award testing. Specific techniques included are simply illustrative of the many which can be drawn upon. When the credibility of LCC element estimates cannot reasonably be assured prior to award, motivation of sound estimates may be achieved through penalty clauses, warranties, or inclusion of maintenance as a part of the contract. Warranties should be given careful consideration prior to use to ensure that the administrative expenses connected with processing of claims against the contractor will not exceed the value of the correction of the deficiencies.

Pre-award testing is a valuable technique when the equipment is purchased from a Qualified Products List (QPL) or when a number of competitors can produce a few units of required performance without large investment or other commitment. Additional study is needed to determine the relative efficiency of post-award testing with associated penalty provisions, the use of warranties, or contractor maintenance at predetermined prices. In the first, the Government bears the cost of testing. (If the contract specifies that testing is done by the contractor, it is reasonable to expect that the contract price has been adjusted accordingly.) In the second, the cost of a bond may be passed on to the Government in the price. For on-going contractor maintenance, the proposed maintenance price may be higher than the cost of Government-performed maintenance. In all three cases the contract price would be expected to include allowance for the risk involved. It is believed that warranties and contractor maintenance, when they are practical, may be less expensive than post-award testing with penalties. Experimentation with these approaches is urged to gain more knowledge of their merits and drawbacks.

The terms of a price adjustment (penalty) clause must be carefully structured. The purpose is to motivate the contractor to meet the terms he specified. A penalty clause should not be so stringent that a contractor could go out of business because of normal testing error. That point is shown clearly in Case 1 where a 10% variation in fuel consumption results in a life-time fuel cost adjustment of about 3 times the total price of the equipment. If all of the cost of LCC estimate errors were passed on to the contractor, the risk might be so great as to outweigh the value of the contract.

Thus, in most Cases, the penalty clause is worded so that some fraction of the added ownership cost is absorbed by the Government.

This problem can be circumvented in some circumstances by statement of the purchase criteria in terms of utility or amount of service rather than in units of hardware. In Case 2, the Government is purchasing a period of trouble-free surface coverage and the penalty includes the option that the contractor will replace failed items at no cost to the Government. In Case 5, the Government is buying tires for a specified number of aircraft landings and the contractor agrees to supply the number of tires necessary to meet that requirement.

Use of utility criteria is urged with the realization that procurement on this basis is not applicable in many situations.

The listing of LCC elements included in Table A may be used as a guide to the cost elements which may apply in an individual procurement. It should not be expected that all elements will be applicable to each procurement. (The Cases bear this out.) However, persons responsible for structuring procurements should review each element to determine whether it should be included as a single element, divided into sub-elements, or excluded as inapplicable or infeasible.

APPLICABILITY

Effective LCC procurement requires that all life-cycle cost elements considered be real and measurable or capable of being estimated within reasonable tolerance. Thus, LCC can only be applied to procurements where the ultimate product is hardware. There must be some practical means to assure that data obtained from competing companies and used in the award of contracts are valid or that the winner can be held largely responsible for differences in those data and post-award test results. Therefore, some guidelines as to the application of LCC are:

1. LCC cannot be applied to award of contracts whose end products are development reports or designs. It should not be applied to award of contracts for prototypes.

2. If the equipment is on a Qualified Products List or is an off-the-shelf item, pre-award testing should be considered.

3. If the testing and cost measurement period extends beyond the contract closing and final payment, a warranty or performance bond of some type is needed.

4. If the equipment is to be used under predictable operating or ambient conditions, a performance bond is feasible.

5. Tests or data required for purposes other than LCC should be relied on whenever possible for LCC purposes, so as to reduce the incremental cost of LCC analysis.

These guidelines should not be construed as suggesting that LCC concepts should be ignored during the development and design stages of new equipment. LCC considerations should influence the guidance that the Government furnishes the development and

design contractors. Trade-off analyses by those contractors should include LCC. The Government should use LCC in evaluating the results. However, LCC estimates of the form illustrated in the Cases in this Casebook cannot be used in award of the development and design contracts.

Prerequisites for including a particular LCC element in production contract award criteria are:

1. Ability to forecast the amount of the cost with reasonable confidence,
2. Ability to verify the cost amount prior to award or to hold the contractor responsible for it,
3. Ability to state the method for evaluating the cost definitively and with clarity,
4. The economic feasibility of incorporating cost analysis and associated tests in the procurement, and
5. The elements included should be those in which there is reasonable expectation of differences in LCC bids or proposals submitted.

CASE 1

NON-MAGNETIC DIESEL ENGINES FOR SHIPBOARD USE

CASE 1

NON-MAGNETIC DIESEL ENGINES FOR SHIPBOARD USE

This Case is based on IFB600-105-66-S, U. S. Navy Purchasing Office, dated 12 July 1965 with the following amendments:

1. 16 August 1965
2. 23 September 1965
3. 7 October 1965
4. 14 October 1965

This Case is realistic rather than real. Not all of the LCC concepts considered in the Case were used in the actual procurement. In addition, wordings, formats, and calculations have been added to comply with the discounting requirements of DoD Instruction 7041.3 (26 February 1969). While readers who were involved in the procurement will find most of the material familiar, a sufficient number of changes and additions have been made that the Case cannot be considered a statement of historical fact.

The salient feature of this Case is the determination and application of significant operating costs. In addition, it illustrates the effect on contractor choice from using LCC evaluation and indicates the penalty structure for potentially high value LCC elements.

EQUIPMENT HISTORY AND DESCRIPTION

From 1966 through 1970, 56 MSO-type minesweepers are scheduled for modernization, overhaul, and major repair. A part of that modernization and overhaul is the replacement of existing non-magnetic diesel engines.

There are three models of engines (called "Items" in the procurement) to be installed in each ship scheduled for modernization.

Item 1 - 600 Brake Horse Power (BHP) at 2000 to 2300 RPM inclusive Non-Magnetic Diesel Engine, complete with all attached accessories. Right hand rotation (clockwise) when viewed from the engine drive end.

Item 2 - Same as Item 1 except that the engine is equipped with a front end power takeoff for a fire pump drive.

Item 3 - Same as Item 1 except that the engine is naturally aspirated with a continuous rating of 280 BHP at 1800 RPM to operate a ship's service generator.

Seven ships will differ from the others in the number of each item on board. The planned installations are:

	No. of Engines		
Hull No.	Item 1	Item 2	Item 3
421	3	1	2
422,425,440, 442,443,461	4	1	1
All Others	5	1	1

The total procurement package includes 19 items and two options. In addition to the items specified above, Item 12 consists of Item 1 engines purchased for stock, Item 18 is On-Board Repair Parts for Items 1, 2, and 3, and Item 19 is Stock Repair Parts for Items 1, 2, and 3. The two options are for repair parts which may be obtained later under a special specified procedure. The remaining items (4-11, 13-17) cover drawings, manuals, engineering services, etc., which are to be supplied along with the engines.

The planned accession rate of engines and parts is:

Item	1966	1967	1968	1969	1970	Total
1	32	-	84	84	77	277
2	8	-	24	13	12	57
3	8	-	24	13	12	57
12	2	-	12	12	12	38
18*	8 sets	-	19 sets	15 sets	15 sets	57 sets
19*	1 lot	-	1 lot	1 lot	1 lot	4 lots

The performance requirements are a modified version of Military Specification MIL-E-23457A(SHIPS), 4 January 1965, Type B. The modified specification is shown in Appendix A.

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*No. of individual parts constituting a set or lot is specified in Tables 1A and 1B.

The diesel engines presently in use are about 15 years old and are no longer being manufactured. Critical spare parts have had to be procured and manufactured as needed. Special production techniques are required because of the sensitivity of assembly and integrated operation of all parts of the engine.

TABLE 1A

ON BOARD REPAIR PARTS FOR ITEMS 1 AND 2

PART DESCRIPTION	QUANTITY
Cylinder Head Assy	1
Conn. Rod Assy w/Bolts, Nuts & Brgs	2
Piston Assy w/Rings, Pin, Bshgs & Retainers	3
Cylinder Liner	3
Piston Rings	1 set*
Bearing Shell - Crankpin	1 set*
Bearing Shell - Main	1 set*
Exhaust Valve w/Key & Lock	16
Inlet Valve (4 Cycle Only) w/Key & Lock	8
Exhaust Valve Spring	8
Intake Valve Spring (4 Cycle Only)	8
Exhaust Valve Guide	4
Intake Valve Guide (4 Cycle only)	2
Fuel Injection Nozzle or Spray Tip	1 set*

NOTE: *Quantities expressed in sets are based on requirements for one engine.

TABLE 1A (Cont'd)

ON BOARD REPAIR PARTS FOR ITEMS 1 AND 2

PART DESCRIPTION	QUANTITY
Fuel Injector Needle & Guide (If Used)	1 set*
Fuel Injection Pump Assy or Unit Injector	1 set*
Fuel Oil Booster Pump (If Used)	1 set*
Fuel Inj. Pump Plunger & Barrel (If Used)	1 set*
Starting Motor Assy	1
Regulating Governor	1
Lube Oil Pres. Pump	1
Fresh Water Pump	1
Sea Water Pump	2
Fuel Oil Supply Pump	2
Turbocharger	1 set*
Blower (If Used)	1
Overspeed Governor	1

NOTE: *Quantities expressed in sets are based on requirements for one engine.

TABLE 1A (Cont'd)

ON BOARD REPAIR PARTS FOR ITEM 3

PART DESCRIPTION	QUANTITY
Conn. Rod Assy w/Bolts, Nuts & brgs	1
Piston Assy w/Rings, Pin, Bshgs & Retainers	1
Cylinder Liner	1
Bearing Shell - Main	1
Bearing Shell - Main Thrust	1
Exhaust Valve w/Key & Lock	4
Inlet Valve (4 Cycle Only) w/Key & Lock	2
Exhaust Valve Spring	2
Intake Valve Spring (4 Cycle Only)	2
Exhaust Valve Guide	1
Intake Valve Guide (4 Cycle Only)	1
Fuel Injection Nozzle or Spray Tip	3
Fuel Injector Needle & Guide (If Used)	2
Fuel Injection Unit Injector (If Used)	3
Fuel Injection Pump Plunger & Barrel (If Used)	3
Bearing Shell - Crankpin	3

TABLE 1B

STOCK REPAIR PARTS FOR ITEMS 1 AND 2

PART DESCRIPTION	Bid A	Bid B (Multi-Year Procurement)			
	FY 1966 QTY REQD (1)	FY 1966 QTY REQD (1)	FY 1968 QTY REQD (1)	FY 1969 QTY REQD (1)	FY 1970 QTY REQD (1)
Piston	10 Sets	10 Sets	29 Sets	--	334 Sets
Piston Pin	13 Sets	13 Sets	38 Sets	--	334 Sets
Piston Pin Bshgs (2)	13 Sets	13 Sets	38 Sets	--	334 Sets
Piston Rings	40 Sets	40 Sets	114 Sets	40 Sets	628 Sets
Cylinder Liner	10 Sets	10 Sets	29 Sets	--	200 Sets
Piston Pin Brg - Conn Rod Eye	10 Sets	10 Sets	29 Sets	--	334 Sets
Bearings - Conn Rod	20 Sets	20 Sets	57 Sets	--	334 Sets
Bearings - Main	10 Sets	10 Sets	29 Sets	--	334 Sets
Bearings - Exh. Camshft.	10 Sets	10 Sets	29 Sets	--	167 Sets
Bearings - Int. Camshft. (2)	10 Sets	10 Sets	29 Sets	--	167 Sets
Fuel Inj. Pump or Unit Inj.	10 Sets	10 Sets	29 Sets	14 Sets	31 Sets
Fuel Inj. Nozzle or Spray Tip	20 Sets	20 Sets	57 Sets	40 Sets	628 Sets
Fuel Inj. Needle & Guide (2)	10 Sets	10 Sets	29 Sets	40 Sets	628 Sets
Fuel Inj. Pump Plunger & Barrel (2)	10 Sets	10 Sets	29 Sets	40 Sets	628 Sets
Fuel Inj. Pump Camshft. & Bshgs (2)	10 sets	10 Sets	29 Sets	--	100 Sets
Fuel Oil Transfer Pump	4	4	11	5	13
Lube Oil Pressure Pump	4	4	11	5	13
L.O. Pres. Pump Impeller Set	4	4	11	--	167
L.O. Pres. Pump Drive & Driven Shfts & Bshgs	2	2	6	--	167
Fresh Water Pump	4	4	11	5	13
F.W. Pump Impeller Assy	4	4	11	--	167
F.W. Pump Shaft & Bshgs	2	2	6	--	167
F.W. Pump Seal Assy	4	4	11	40	628
Sea Water Pump	2	2	6	--	334
S.W. Pump Shaft & Bshgs	2	2	6	--	334
S.W. Pump Impeller	4	4	11	40	628

NOTES: See end of Table

TABLE 13 (Cont'd)

STOCK REPAIR PARTS FOR ITEMS 1 AND 2

PART DESCRIPTION	Bid A	Bid B (Multi-Year Procurement)			
	FY 1966 QTY REQD (1)	FY 1966 QTY REQD (1)	FY 1968 QTY REQD (1)	FY 1969 QTY REQD (1)	FY 1970 QTY REQD (1)
S.W. Pump Seal Assy	4	4	11	40	628
Blower Rotor Assy (2)	4 Sets	4 Sets	11 Sets	--	94 Sets
Blower Rotor Drive & Driven Gear (2)	5 Sets	8 Sets	22 Sets	--	168 Sets
Blower Rotor Bearings (2)	8 Sets	8 Sets	22 Sets	--	167 Sets
Blower Coupling (2)	8 Sets	8 Sets	22 Sets	--	67 Sets
Turbocharger Rotor Assy	10 Sets	10 Sets	29 Sets	--	167 Sets
Turbocharger Impeller Assy (3)	10 Sets	10 Sets	29 Sets	--	167 Sets
Turbocharger Rotor Bearings	30 Sets	30 Sets	86 Sets	--	334 Sets
Turbocharger Nozzle Ring Assy	20 Sets	20 Sets	57 Sets	--	334 Sets
Turbocharger Diffuser	20 Sets	20 Sets	57 Sets	--	334 Sets
Exhaust Valve	20 Sets	20 Sets	57 Sets	--	334 Sets
Intake Valve (2)	20 Sets	20 Sets	57 Sets	--	334 Sets
Vibration Damper (Viscous) (2)	4	4	11	5	84
Cone-Mech. Type Vibration Damper (2)	4	4	11	--	167
Rub.-Mech. Type Vibration Damper (2)	4	4	11	--	84
Cylinder Head	4 Sets	4 Sets	11 Sets	5 Sets	47 Sets
Connecting Rod	2 Sets	2 Sets	6 Sets	3 Sets	22 Sets
Camshaft - Exhaust	4 Sets	4 Sets	11 Sets	5 Sets	13 Sets
Set Timing Gears or Chain	4	4	11	--	334
Cylinder Block	2	2	6	3	22
Governor Assy	2	2	6	3	22
Crankshaft	2	2	6	3	22
Blower (2)	2 Sets	2 Sets	6 Sets	3 Sets	6 Sets
Turbocharger	2 Sets	2 Sets	6 Sets	3 Sets	6 Sets

NOTES: See end of Table

TABLE 1B (Cont'd)

STOCK REPAIR PARTS FOR ITEM 3

PART DESCRIPTION	Bid A	Bid B (Multi-Year Procurement)			
	FY 1966 QTY REQD (1)	FY 1966 QTY REQD (1)	FY 1968 QTY REQD (1)	FY 1969 QTY REQD (1)	FY 1970 QTY REQD (1)
Piston	2 Sets	2 Sets	5 Sets	--	57 Sets
Piston Pin	3 Sets	3 Sets	6 Sets	--	57 Sets
Piston Pin Bshgs (2)	3 Sets	3 Sets	6 Sets	--	57 Sets
Piston Rings	8 Sets	3 Sets	19 Sets	8 Sets	49 Sets
Cylinder Liner	2 Sets	2 Sets	5 Sets	--	34 Sets
Piston Pin Brg - Conn Rod Eye	2 Sets	2 Sets	5 Sets	--	57 Sets
Bearings - Conn Rod	4 Sets	4 Sets	10 Sets	--	57 Sets
Bearings - Main	2 Sets	2 Sets	5 Sets	--	57 Sets
Bearings - Exh. Camshft.	2 Sets	2 Sets	5 Sets	--	29 Sets
Bearings - Int. Camshft. (2)	2 Sets	2 Sets	5 Sets	--	29 Sets
Fuel Inj. Pump or Unit Inj.	2 Sets	2 Sets	5 Sets	2 Sets	5 Sets
Fuel Inj. Nozzle or Spray Tip	4 Sets	4 Sets	10 Sets	8 Sets	49 Sets
Fuel Inj. Needle & Guide (2)	2 Sets	2 Sets	5 Sets	8 Sets	49 Sets
Fuel Inj. Pump Plunger & Barrel (2)	2 Sets	2 Sets	5 Sets	8 Sets	49 Sets
Fuel Inj. Pump Camshft. & Bshgs (2)	2 Sets	2 Sets	5 Sets	--	17 Sets
Fuel Oil Transfer Pump	1	1	2	1	2
Lube Oil Pressure Pump	1	1	2	1	2
L.O. Pres. Pump Impeller Set	1	1	2	--	29
L.O. Pres. Pump Drive & Driven Shfts & Bshgs	1	1	1	--	29
Fresh Water Pump	1	1	2	1	2
F.W. Pump Impeller Assy	1	1	2	--	29
F.W. Pump Shaft & Bshgs	1	1	1	--	29
F.W. Pump Seal Assy	1	1	2	8	49
Sea Water Pump	1	1	2	1	2
S.W. Pump Shaft & Bshgs	1	1	1	--	57
S.W. Pump Impeller	1	1	2	8	49

NOTES: See end of Table

TABLE 1B (Cont'd)

STOCK REPAIR PARTS FOR ITEM 3

PART DESCRIPTION	Bid A	Bid B (Multi-Year Procurement)			
	FY 1966 QTY REQD (1)	FY 1966 QTY REQD (1)	FY 1968 QTY REQD (1)	FY 1969 QTY REQD (1)	FY 1970 QTY REQD (1)
S.W. Pump Seal Assy	1	1	2	8	49
Blower Rotor Assy (2)	1 Set	1 Set	2 Sets	--	14 Sets
Blower Rotor Drive & Driven Gear (2)	2 Sets	2 Sets	4 Sets	--	29 Sets
Blower Coupling (2)	2 Sets	2 Sets	4 Sets	--	11 Sets
Turbocharger Rotor Assy	2 Sets	2 Sets	5 Sets	--	29 Sets
Turbocharger Impeller Assy (3)	2 Sets	2 Sets	5 Sets	--	29 Sets
Turbocharger Rotor Bearings	4 Sets	4 Sets	15 Sets	--	57 Sets
Turbocharger Nozzle Ring Assy	4 Sets	4 Sets	15 Sets	--	57 Sets
Turbocharger Diffuser	4 Sets	4 Sets	15 Sets	--	57 Sets
Exhaust Valve	4 Sets	4 Sets	15 Sets	--	57 Sets
Intake Valve (2)	4 Sets	4 Sets	15 Sets	--	57 Sets
Vibration Damper (Viscous) (2)	1	1	2	1	10
Cone-Mech. Type Vibration Damper (2)	1	1	2	--	29
Rub.-Mech. Type Vibration Damper (2)	1	1	2	--	14
Cylinder Head	1 Set	1 Set	2 Sets	1 Set	7 Sets
Connecting Rod	1 Set	1 Set	1 Set	1 Set	3 Sets
Camshaft - Exhaust	1 Set	1 Set	2 Sets	1 Set	2 Sets
Camshaft - Intake (2)	1 Set	1 Set	2 Sets	1 Set	2 Sets
Set Timing Gears or Chain	1	1	2	--	57
Cylinder Block	1	1	1	1	3
Governor Assy	1	1	1	1	3
Crankshaft	1	1	1	1	3
Blower (2)	1 Set	1 Set	1 Set	1 Set	1 Set
Turbocharger	1 Set	1 Set	1 Set	1 Set	1 Set

NOTE: (1) Quantities expressed in sets are based on requirements for one engine.
(2) If used.
(3) If not included with rotor assembly.

TABLE 1C

LIFE CYCLE COST ELEMENTS - CASE 1

Initial

Purchase Price - INCLUDED.

Delivery (Transportation) - N.I. All items forwarded to common delivery point by contractor.

Testing - N.I. No difference among bidders expected

Installation and Start-up - N.I. Included in bid as Items 15 and 16 with a design deficiency clause.

Inventory Management - INCLUDED.

Training - INCLUDED.

Operating

Item Life - INCLUDED.

Operating Labor - N.I. No difference from existing conditions expected.

Materials - INCLUDED.

Utilities - N.I.

Training - INCLUDED.

Preventive Maint. - N.I.

Corrective Maint. - N.I.

Inventory: Management - INCLUDED

Requirements - INCLUDED

Final

Dismantling - N.I.

Residual Value - N.I.

N.I. - Not Included.

LIFE CYCLE COST ELEMENTS

Table 1C (page 12) shows the LCC elements which are included.

MATERIALS This Case provides an example of the use of the material consumption of a piece of equipment during the expected life cycle as a factor in the contract award. The material consumed is diesel fuel oil. The wording included in the actual IFB is as follows:

Specific Fuel Consumption as a Factor in Bid Evaluation

1. Computation of Average Specific Fuel Consumption

(a) Average Specific Fuel Consumption (ASFC) will be computed by each bidder for a representative engine of Items 1 and 2 and for a representative engine of Item 3 based upon the following operating times and corrected brake-horse powers, and information will be supplied by each bidder under Columns 3 and 4:

Column 1	Column 2	Column 3	Column 4
Percent of Operating Time	Percent of Corrected Rated Brake Horse Power*	Fuel Consumed (lbs/hr) x Col. 1 Items 1 & 2	Fuel Consumed (lbs/hr) x Col. 1 Item 3
10	33 - 1/3		
15	50		
30	66 - 2/3		
35	83 - 1/3		
10	100		
TOTAL 100	70%		

*Loading for Items 1 and 2 shall be at optimum speed for the lowest fuel consumption.

*Loading for Item 3 shall be at 1800 RPM.

(b) The following formula shall be applied to compute the average specific fuel consumption for Items 1 and 2.

Formula 1(b) ASFC = $\frac{\text{Total Column 3}}{\text{420 (BHP)}} = \frac{\text{\_\_\_\_\_}}{\text{(Bidder to fill in)}}$

(c) The following formula shall be applied to compute the average specific fuel consumption for Item 3.

Formula 1(c) ASFC - $\frac{\text{Total Column 4}}{\text{196 (BHP)}} = \frac{\text{\_\_\_\_\_}}{\text{(Bidder to fill in)}}$

(d) The Average Specific Fuel Consumptions which each bidder has computed by Formulae 1(b) and 1(c) will be used as a factor in award evaluation under Bid A and Bid B before the multi-year procurement formula is applied. The monetary values of the Average Specific Fuel Consumption Factors will be computed for the respective Items as follows:

Items 1 and 2:

Formula 1(d) - (Average Specific Fuel Consumption - 0.380) x $100,000* x 15

Item 3:

Formula 1(e) - (Average Specific Fuel Consumption - 0.380) x $80,000* x 15

The values obtained from Formulae 1(d) and 1(e) will be discounted and added to the unit prices of Items 1 and 2 and Item 3 respectively for bid evaluation purposes before application of the multi-year procurement formula.

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*The values of $100,000 and $80,000 per pound per BHP per hour used here and in Section 3 for annual fuel costs were established by:

a. inspection of minesweeper steaming logs,
b. discussion with appropriate ships personnel,
c. consideration of anticipated scenarios for future minesweeper deployments, and
d. average purchase cost of diesel fuel.

2. Verification of Average Specific Fuel Consumption

The Average Specific Fuel Consumption of production engines will be verified during the period of this contract by the testing of 5% of the engines from Items 1 and 2 and 5% of the engines from Item 3 (minimum of one engine) such engines to be selected in a random manner by a Government representative from engines, including accessories, which have been completely manufactured and upon which tests in accordance with paragraph 4.3.3 of MIL-E-23457A(SHIPS, have been completed but which have not been painted and prepared for delivery. These engines shall be representative in every respect, including accessories, of engines deliverable under this contract.

These tests shall be of one-fourth hour duration for each operating horse power indicated above, with sufficient time interval between each run for stabilization.

Tests shall be conducted at the Contractor's plant at his expense, utilizing the fuel corresponding to MIL-F-16884 and lubricating oil in accordance with symbol 9250 of MIL-L-9000. Fuel will have a maximum cetane number of 52, and fuel consumption shall be corrected for the difference in the high heat value of the fuel actually used during the tests and the standard of 19,350 BTU/lb. Horse-power shall be corrected to ambient conditions specified in Military Specification MIL-E-23457A(SHIPS).

3. Reduction in Price for Failure to Meet Average Specific Fuel Consumption set forth by Contractor in his bid

In the event that the actual average specific fuel consumption of the test engines representative in all respects, including accessories, of engines deliverable under Items 1 and 2 and/or Item 3, respectively, as demonstrated by the results of the engine tests conducted in accordance with Paragraph 2 above, is greater than the average specific fuel consumption computed and set forth by the Contractor in his bid in accordance with Paragraph 1 above for engines deliverable under Items 1 and 2 and/or Item 3, then a reduction in the contract price of Items 1 and 2 and/or Item 3 shall be made in accordance with the following formula:

Formula 1(f) (Actual(Test)ASFC - Bid ASFC - 0.010) x $100,000 x 0.954* x Number of engines delivered under Items 1 and 2.

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*Present value factor for costs incurred in the first year.

Formula 1(g) (Actual(Test)ASFC - Bid ASFC - 0.010) x $80,000 x 0.954* x Number of engines delivered under Item 3.

By this formula a variance of 0.010 in ASFC is permitted without reduction in price.

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*See footnote, pg. 15.

ITEM LIFE — The purpose of including the item life in a life cycle costing procurement is to provide the limits between which costs will be considered.

The expected service life of the ship operating in the deployment scenarios presently forecast is 30 years. Based on experience and engineering judgment, it is assumed that a major overhaul will be performed after 15 years of operation. It is further assumed that this major overhaul will include replacement or equivalent modification and repair of the diesel engines. The average annual engine use is estimated at 2000 hours. The total life of the diesel engines being procured is therefore estimated to be 30,000 operating hours.

Minor overhaul and general refurbishing is planned after each 4,000 operating hours. However, this is an estimate subject to later modification. It is hoped that this time period may be lengthened to 6,000 hours. Since all of the engines submitted are subject to this overhaul estimate, consideration of time between overhauls has not been included as an award criterion.

TRAINING — Training costs were not included as a life cycle cost element in the actual procurement. At the time of case preparation, no known Navy procurements have included training cost. However, the Navy (and the other Services) have actively been investigating the life cycle cost aspects of training. On the basis of preliminary work done to date, the following is included as a preliminary example of the inclusion of training costs in a procurement.

Life Cycle Training Costs in Bid Evaluation and Award. It is expected that, during the entire ownership period of this equipment by the Navy, training must be provided on a recurring basis for the operation, maintenance and management of this equipment. The costs incurred by the Government to provide this training will be considered, evaluated, and used in the determination of the contract award.

Training requirements are divided into three categories - initial training, training equipment (materials and installation), and recurring training.

All materials (equipments, manuals, training aids, texts, guides, etc.) required to be furnished by the contractor for training purposes are in addition to the Items specified in the bid descriptions and specifications.

All training equipments and materials, aids, instructors, and other personnel are to be supplied in accordance with NAVSHIPS 0900-032-6010/NAVPERS93904 unless specifically changed by this contract or subsequent amendments to this contract.

All data and prices set forth under the following sections become a part of this contract and all materials and services specified will be delivered and performed at the designated prices.

A. The Life Cycle Training Cost to be used as a basis for evaluation and award will be

$$LCC_{TR} = A_{TR} + I_{TR} + R_{TR}$$

where

LCC_{TR} = Life Cycle Training Cost

A_{TR} = Cost of equipments and materials furnished by the contractor and installed or used at designated Navy Training Schools

I_{TR} = Initial costs of training selected Navy personnel and employees who will then be used as a training cadre

R_{TR} = Recurring training costs expected to be incurred over the estimated equipment life

B. Equipments and Materials will consist of

1. Fully operational units of Bid Item 1.

2. Fully operational units of Bid Item 3.

3. Units of Bid Items 1 and 3 with appropriate cut-aways to illustrate proper operation and maintenance.

4. Models, enlargements, and test equipment appropriate to the course of instruction to be supplied by the contractor.

5. Installation and pre-instruction testing for items 1 through 4, above.

C. Initial Training Costs will consist of all costs incurred by the government in the training of an adequate cadre of professional and maintenance personnel who will then become the instructors for recurrent training. The initial training will be conducted by the contractor at his plant unless specified otherwise in this contract. The costs to be considered include.

1. Student pay, per diem, and allowances.

2. Student travel.

3. All costs charged to the government by the contractor in the performance of the initial training prescribed in this contract.

D. Recurring Training Costs are those costs incurred by the government in the training of personnel to operate, maintain, and manage the equipment being purchased over its entire estimated life.

These costs will include

1. All student pay and allowances.

2. Student travel.

3. Contractor's course monitoring during a specified time period to ensure proper instruction.

4. All materials issued to each student (tests, guides, charts, manuals, etc.).

E. Calculation of Life Cycle Training Costs*

	Data Supplied by* A	B	C	D
1. Equipments and Materials				
a. One operational unit of Bid Item 1 (Bidder shall enter same unit price as shown elsewhere in this contract) $_____		X		
b. One operational unit of Bid Item 3 (Bidder shall enter same unit price as shown elsewhere in this contract) $_____		X		
c. Cutaway units specified in B.3 above in sufficient quantity for use in one classroom and one shop or laboratory simultaneously $_____		X		
d. Models, enlargements, and test equipment specified in B.4 above in sufficient quantity for use in one classroom and one shop or laboratory simultaneously. $_____		X		
e. Total of Items 1.a through 1.d above $_____		X		
f. No. of classroom/shop/lab units to be supplied 2			X	X

A Government shall enter
B Bidder shall enter
C Government shall enter with bidder's option
D Entry shall be made prior to solicitation preparation

*The factors used in this section are for case presentation purposes only and are not to be construed as official or recommended Navy data.

		Data Supplied by* A	B	C	D
g.	Installation costs				
	No. of Class/ Shop/Lab Units / Location			X	X
	1 MINE WAR TRA PAC Long Beach Calif. $_____		X		
	1 MINE WAR SCH Charleston, S.C. $_____		X		
	(extend as needed)				
h.	Total Equipment and Materials 1.e x 1.f $_____		X		
i.	Total Installed Equipment and Materials 1.g + 1.h $_____		X		
2.	Initial Training Costs - conducted at bidder's plant IAW NAVSHIPS 0900-032-6010/NAVPERS 93904.			X	X
a.	Training will be conducted over a period of one year after the date of this contract.			X	X
b.	Number of students trained during period in 2a.				
	(1) Professional level 40			X	X
	(2) Maintenance level 80			X	X

A Government shall enter
B Bidder shall enter
C Government shall enter with bidder's option
D Entry shall be made prior to solicitation preparation.

*The factors used in this section are for case presentation purposes only and are not to be construed as official or recommended Navy data.

		Data Supplied by* A	B	C	D
c.	Average estimated pay and allowances per student per week.**				
	(1) Professional level $500.00	X			X
	(2) Maintenance level $375.00	X			X
d.	Estimated round-trip travel cost per student $_____ (Assume student source distribution to be equally divided between locations in l.g. and travel by commercial air.)		X		
e.	Course length, ____ weeks		X		
f.	Bidder's incurred costs, chargeable to the government, per student per course $_____		X		
g.	Total Initial Training Costs 2.e [(2.b.(1)) (2.c.(1)) + (2.b.(2)) (2.c.(2))] + [2.b.(1) + 2.b.(2)][2.d + 2.f] $_____				X
3.	Recurring Training Costs (Excl. initially trained cadre)				

A Government shall enter
B Bidder shall enter
C Government shall enter with bidder's option
D Entry shall be made prior to solicitation preparation.

*The factors used in this section are for case presentation purposes only and are not to be construed as official or recommended Navy data.

**The data shown are for presentation purposes only. However, they should include salary and fringe benefits, housing, subsisistence, and incidental reimbursable expenses while away from home.

		Data Supplied by* A	B	C	D
a.	Equipment life 15 years	X			X
b.	Desired manning level for personnel knowledgeable of engineering and maintenance				
	(1) Professional level 400			X	X
	(2) Maintenance level 700			X	X
c.	Estimated turnover rate for personnel knowledgeable of engineering and maintenance.				
	(1) Professional level 5 years	X			X
	(2) Maintenance level 2½ years	X			X
d.	Average estimated pay and allowances per student per week.**				
	(1) Professional level $280.10	X			X
	(2) Maintenance level $112.40	X			X
e.	Estimated round-trip travel cost per student $N/A	X			X
f.	Course length, weeks ____		X		
g.	Cost of texts, learning guides, manuals, etc., supplied by bidder, per student $_____		X		

A Government shall enter
B Bidder shall enter
C Government shall enter with bidder's option
D Entry shall be made prior to solicitation preparation.

*The factors used in this section are for case presentation purposes only and are not to be construed as official or recommended Navy data.

**Course assumed to be given at home station. Although data shown are only for presentation purposes, all pay and fringe benefits should be included.

		Data Supplied by*			
		A	B	C	D
h.	Cost to government of conducting course, excl. student costs, per student-week. $62.25			X	X
i.	Contractor's cost of monitoring classes during the 1st year** and providing needed changes in guides, texts, manuals, etc. $_____		X	X	
j.	Total life cycle recurring training costs $_____		X		

$$3a\left[\left[\frac{3b1}{3c1}\ (3f(3h+3d1)+3e+3g)\right]+\left[\frac{3b2}{3c2}\ (3f(3h+3d2)+3e+3g)\right]\right]+3i$$

4. Total Life Cycle Training Costs, 1i+2g+3j $_____ X

F. Calculation of Present Value of Training Costs

All training costs for each bid as specified and calculated in Section E above will be discounted to a present value at a rate of 10% per year. The time flow characteristics will satisfy these assumptions.

1. Equipment and materials (E) will be purchased and installed at a uniform rate during the first contract year.

A Government shall enter
B Bidder shall enter
C Government shall enter with bidder's option
D Entry shall be made prior to solicitation preparation.

*The factors used in this section are for case presentation purposes only and are not to be construed as official or recommended Navy data.

**Government shall enter the period of time, e.g., 1st year, etc., prior to solicitation preparation.

2. Initial training costs will be incurred at a uniform rate over the first contract year.

3. Recurring training costs will be incurred at a uniform rate during the 2nd through the 16th year.

INVENTORY COSTS

One area of costs incurred by the government in equipment supply is the management of the inventory of spare parts, components, and items. As the inventory of spares increases, it is logical to estimate that the management costs also increase. In addition, if the total inventory were to remain constant in terms of total units or dollar value, but the number of different items were to increase, an increase in management costs may be expected. This case considers the cost aspect of the latter situation.

The wording of the following section, like that for Training Costs, is used here for case presentation purposes.

Costs of Inventory Additions. In order to determine the added costs to the government of introducing items into the existing inventory and stock system, the bidder will insert, on the indicated line below, the total number of new parts, components, units, sub-assemblies, or items which are to be used in maintaining and repairing his equipment and which are not stocked by the Navy. A new part, component, unit, sub-assembly or item is defined as one not presently having a Federal Stock Number (FSN). The bidder may establish the number of new Federal Stock Numbers required from reviewing previous Allowance Parts Lists or from repair parts requirements set forth in the basic contract specification. The bidder shall indicate in the following space the source used for his determination.

No. of New FSN's _____

Source:

Criteria for Bid Evaluation and Award. The cost for initial introduction of a new FSN is $100.00. The cost for continuing inventory item management is $50.00 per year of estimated item life. The estimated item life for the equipments being procured by this contract is 15 years. The procurement period is 5 years. The total inventory holding period is 20 years. The total discounted cost of inventory introduction and management of each new FSN is $546.65.

Contract Adjustment. If, after the award of the contract, the successful bidder incorporates in the equipment parts which require the assignment of new Federal Stock Numbers in excess of the number set forth in his bid and stated in the contract, the total contract price shall be decreased in accordance with the following formula:

[(Number of new FSN's actually needed to meet the parts requirements of the contract)-----LESS-----(Number of new FSN's set forth in the bid and stated in the contract)] -----TIMES----- ($546.65).

* * * *

Part of the life cycle costs of a reparable item is the spare parts requirements. For a specialized piece of equipment such as a non-magnetic diesel engine, experience showed that later procurement of spares could be an expensive and time-consuming process. Therefore, based on experience and operating data, estimates of spares requirements were made and spares were included in the engine purchase.

BID ANALYSIS

Bidders were requested to supply two bids each. Bid A would represent only the 1966 requirements. Bid B would represent the total requirements for the overhaul plan. A bidder could submit only Bid A or both Bid A and B. A bidder submitting Bid B only would be considered non-responsive.

Four bidders responded and the pertinent bid data are shown on Tables 1D-1E. Only the data for Bid B have been shown.

Bidder C is the award winner.

TABLE 1D

LIFE CYCLE TRAINING COSTS: BID DATA

Cost Element (Section No.)	BIDDER A	B	C	D
Bid Item 1 (E1a)	$ 63,374.00	$ 31,900.00	$ 24,973.00	$ 19,614.00
Bid Item 3 (E1b)	60,812.00	32,438.00	26,272.00	19,196.00
Cutaway Units (E1c)	69,463.00	32,120.00	29,161.00	30,265.00
Models and Test Equipment (E1d)	6,150.00	9,322.00	13,769.00	8,117.00
Sub-Total (E1e)	$ 199,799.00	$ 105,780.00	$ 94,175.00	$ 77,192.00
Installation (E1g): Long Beach	4,325.00	4,227.00	4,727.00	4,109.00
Charleston	3,876.00	3,978.00	4,071.00	4,091.00
Total Installed Equip. & Mat'ls (E1i)	$ 407,799.00	$ 219,765.00	$ 197,148.00	$ 162,664.00
Present Value: Installed Equipment and Materials (F)	$ 389,040.25	$ 209,655.81	$ 188,079.19	$ 155,181.46
Travel/Student (E2d)	$ 139.54	158.23	128.30	142.78
Course length (E2e)	6 wks	5 wks	6 wks	6 wks
Course Costs, per student (E2f)	2,320.00	2,018.00	2,472.00	2,274.00
Total Initial Training Costs (E2g)	$ 595,144.80	$ 511,147.60	$ 612,036.00	$ 590,013.60
Present Value: Initial Trng. Costs (F)	$ 567,768.14	$ 487,634.81	$ 583,882.34	$ 562,872.97
Course length (E3f)	6 wks	5 wks	6 wks	6 wks
Cost of Supplies, per student (E3g)	84.53	65.21	74.69	177.54
Monitoring Costs (E3i)	6,720.00	8,320.00	4,371.00	7,888.00
Total Recurring Training Costs (E3j)	$7,329,282.00	$6,082,234.00	$7,273,797.00	$7,508,704.00
Present Value: Recurring Trng. Costs (F)	$3,547,505.39	$2,944,963.18	$3,519,768.70	$3,634,733.57
Total Life Cycle Trng. Cost (E4)	$8,332,225.80	$6,813,146.60	$8,082,981.00	$8,261,381.60
Present Value: Total Life Cycle Training Cost (F)	$4,504,313.78	$3,642,253.80	$4,291,730.23	$4,352,788.00

EXPLANATORY NOTES TO TABLE 1D

Initial Training Costs - Calculation:

Using Bid A as an example, note that most of the factors are expressed in terms of one week and the length of the course is six weeks. Thus, 40 students at the professional level with pay, allowances, and expenses of $500 per student per week requires the multiplication of $500 times 40 which equals $20,000. Eighty students at the maintenance level with weekly pay, allowances, and expenses of $375 using the same arithmetic would equal $30,000. The sum of these figures is $50,000. This figure multiplied by six, which is the number of weeks involved in the course, gives a product of $300,000. The total number of students, i.e., 40 professionals and 80 maintenance level, is 120. The travel cost per student for conducting the course is $2,320. The sum of these two figures is $2,459.54. Since there are 120 students that figure must be multiplied by 120; the product of which is $295,144.80. This figure added to the $300,000 previously mentioned represents Bidder A's total initial training cost of $595,144.80. The present value is then calculated by multiplying the total initial training cost by the factor in DoD instruction 7041.3 (0.954).

Recurring Training Costs - Calculation:

Again using Bid A as an example, since the desired manning level for professionals is 400 and the estimated turnover rate for them is five years, the first step is to divide 5 into 400. Likewise, for maintenance level personnel, since the number is 700 and the estimated turnover is 2.5 years, the same division occurs. Dealing now with professional level people, it should be noted that the cost to the Government per student week for conducting the course is $62.25, plus the weekly pay allowance for professionals of $280.10. The sum of these figures is $342.35. Since the length of the course is six weeks, this figure must be multiplied by six. The product of this multiplication is $2,054.10. The cost of texts, learning guides, manuals, etc., supplied by Bidder A per student is $84.53. This added to the previous sum gives a new sum of $2,138.63. Since the division of 5 into 400 gives us 80, this sum must be multiplied by 80. The product of this is $171,090.40.

The same calculation stated above is to be made in regard to maintenance level personnel. This calculation, made in the same way, results in the sum of $317,080.40. The sum of both figures

EXPLANATORY NOTES TO TABLE 1D (continued)

is $488,170.80. Since the recurring training is to be given over a period of 15 years, this sum must be multiplied by 15. The product of this calculation is $7,322,562.00. To this must be added Bidder A's cost of monitoring classes during the first year of recurrent training. This is $6,720.00. The sum of this addition is $7,329,282.00.

The present value is calculated by multiplying $488,170.80 by the factor for a cash flow occurring uniformly from the second through the sixteenth year (8.209 - 0.954 = 7.255) with the result of $3,541.679.15. Then, the present value of $6,720.00 spent uniformly during the second project year (the first year of recurring training) is calculated by multiplying that number by 0.867, yielding $5,826.24. Adding the two products gives the total present value of recurring training as $3,547,505.39.

Equipment and Materials and Total Training Costs

These sums are simply explained in the text. The equipment and materials calculation is the sum of the values of the equipment needed for one training center times the number of training centers to which is added the cost of installation. The present value is 0.954 times the total equipment and materials cost.

Total training costs (total real dollars and present value) is the sum of the appropriate values for equipment and materials, initial training cost, and recurring training costs.

Table 1E

SUMMARY OF BID DATA - CASE 1

Item No.	Bid and Evaluation Element		Quantity	BIDDER A Unit Price	Bid	Discount Factor	Present Value
1	600 BHP Diesel	1st yr.	32	$ 63,374	$ 2,027,968	0.954	$ 1,934,681.47
		2nd yr.	-	-	-	-	-
		3rd yr.	84	63,374	5,323,416	0.788	4,194,851.81
		4th yr.	84	63,374	5,323,416	0.717	3,816,889.27
		5th yr.	77	63,374	4,879,798	0.652	3,181,628.30
2	600 BHP Diesel w/PTO	1st yr.	8	64,295	514,360	0.954	490,699.44
		2nd yr.	-	-	-	-	-
		3rd yr.	24	64,295	1,543,080	0.788	1,215,947.04
		4th yr.	13	64,295	835,835	0.717	599,293.70
		5th yr.	12	64,295	771,540	0.652	503,044.08
3	280 BHP Diesel	1st yr.	8	60,812	486,496	0.954	464,117.18
		2nd yr.	-	-	-	-	-
		3rd yr.	24	60,812	1,459,488	0.788	1,150,076.54
		4th yr.	13	60,812	790,556	0.717	566,828.65
		5th yr.	12	60,812	729,744	0.652	475,793.09
12	600 BHP Diesel	1st yr.	2	63,377	126,754	0.954	120,923.32
		2nd yr.	-	-	-	-	-
		3rd yr.	12	63,377	760,524	0.788	599,292.91
		4th yr.	12	63,377	760,524	0.717	545,295.71
		5th yr.	12	63,377	760,524	0.652	495,861.65
15	Engineering Services, Man Days	1st yr.	100	80	8,000	0.954	7,632.00
		2nd yr.	-	-	-	-	-
		3rd yr.	200	80	16,000	0.788	12,608.00
		4th yr.	150	80	12,000	0.717	8,604.00
		5th yr.	150	80	12,000	0.652	7,824.00
18	O/B Repair Parts, Sets	1st yr.	8	10,725	85,800	0.954	81,853.20
		2nd yr.	-	-	-	-	-
		3rd yr.	19	10,725	203,775	0.788	160,574.70
		4th yr.	15	10,725	160,875	0.717	115,347.38
		5th yr.	15	10,725	160,875	0.652	104,890.50
19	Stock Repair Parts (Table 1B)	1st yr.	1 lot	1,790,624.75	1,790,624.75	0.954	1,708,256.01
		2nd yr.	-	-	-	-	-
		3rd yr.	1 lot	1,790,624.75	1,790,624.75	0.788	1,411,012.30
		4th yr.	1 lot	1,790,624.75	1,790,624.75	0.717	1,283,877.95
		5th yr.	1 lot	1,790,624.75	1,790,624.75	0.652	1,167,487.34
Total Bid Elements					$34,915,847.00		$26,425,191.54
ASFC - Item 1 & 2					0.380		
ASFC - Item 3					0.380		
ASFC Adjustment (15 yrs.)							
Engines purchased in:	1st yr.						
	Item 1&2	40			0	7.255	0
	Item 3	8			0	7.255	0
	2nd yr.	-			-	-	-
Note: Present value equals "Bid" divided by 15 and multiplied by "Discount Factor."	3rd yr.						
	Item 1&2	108			0	5.996	0
	Item 3	24			0	5.996	0
	4th yr.						
	Item 1&2	97			0	5.451	0
	Item 3	13			0	5.451	0
	5th yr.						
	Item 1&2	89			0	4.956	0
	Item 3	12			0	4.956	0
Trng. Adjustment (See Table 1D)					$ 8,332,225.80		$ 4,504,313.78
Inventory Management Adj. - New FSNs				18	15,300		9,839.70
Total Cost Evaluation					$43,263,372.80		$30,939,345.02

(continued)

Table 1E (Cont'd)

SUMMARY OF BID DATA - CASE 1

Item No.	Bid and Evaluation		Quantity	BIDDER B Unit Price	Bid	Discount Factor	Present Value
1	600 BHP Diesel	1st yr.	32	$ 31,900	$ 1,020,800	0.954	$ 973,843.20
		2nd yr.	-	-	-	-	-
		3rd yr.	84	31,900	2,679,600	0.788	2,111,524.80
		4th yr.	84	31,900	2,679,600	0.717	1,921,273.20
		5th yr.	77	31,900	2,456,300	0.652	1,601,507.60
2	600 BHP Diesel w/PTO	1st yr.	8	32,750	262,000	0.954	249,948.00
		2nd yr.	-	-	-	-	-
		3rd yr.	24	32,750	786,000	0.788	619,368.00
		4th yr.	13	32,750	425,750	0.717	305,262.75
		5th yr.	12	32,750	393,000	0.652	256,236.00
3	280 BHP Diesel	1st yr.	8	32,438	259,504	0.954	247,566.82
		2nd yr.	-	-	-	-	-
		3rd yr.	24	32,438	778,512	0.788	613,467.46
		4th yr.	13	32,438	421,694	0.717	302,354.60
		5th yr.	12	32,438	389,256	0.652	253,794.91
12	600 BHP Diesel	1st yr.	2	31,900	63,800	0.954	60,865.20
		2nd yr.	-	-	-	-	-
		3rd yr.	12	31,900	382,800	0.788	301,646.40
		4th yr.	12	31,900	382,000	0.717	274,467.60
		5th yr.	12	31,900	382,800	0.652	249,585.60
15	Engineering Services, Man Days	1st yr.	100	80	8,000	0.954	7,632.00
		2nd yr.	-	-	-	-	-
		3rd yr.	200	80	16,000	0.788	12,608.00
		4th yr.	150	80	12,000	0.717	8,604.00
		5th yr.	150	80	12,000	0.652	7,824.00
18	O/B Repair Parts, Sets	1st yr.	8	4,165.34	33,322.72	0.954	31,789.87
		2nd yr.	-	-	-	-	-
		3rd yr.	19	4,165.34	79,141.46	0.788	62,363.47
		4th yr.	15	4,165.34	62,480.10	0.717	44,798.23
		5th yr.	15	4,165.34	62,480.10	0.652	40,737.03
19	Stock Repair Parts (Table 1B)	1st yr.	1 lot	361,163.60	361,163.60	0.954	344,550.07
		2nd yr.	-	-	-	-	-
		3rd yr.	1 lot	361,163.60	361,163.60	0.788	284,596.92
		4th yr.	1 lot	361,163.60	361,163.60	0.717	258,954.30
		5th yr.	1 lot	361,163.60	361,163.60	0.652	235,478.67
Total Bid Elements					$15,494,294.78		$11,682,648.70
ASFC - Item 1 & 2					0.410		
ASFC - Item 3					0.475		
ASFC Adjustment (15 yrs.)							
Engines purchased in:	1st yr.						
	Item 1&2		40		$ 1,800,000	7.255	$ 869,266.67
	Item 3		8		912,000	7.255	441,104.00
	2nd yr.		-		-	-	-
Note: Present value equals "Bid" divided by 15 and multiplied by "Discount Factor."	3rd yr.						
	Item 1&2		108		4,860,000	5.996	1,942,704.00
	Item 3		24		2,736,000	5.996	1,093,670.40
	4th yr.						
	Item 1&2		97		4,365,000	5.451	1,586,241.00
	Item 3		13		1,482,000	5.451	538,558.80
	5th yr.						
	Item 1&2		89		4,005,000	4.956	1,323,252.00
	Item 3		12		1,368,000	4.956	451,987.20
Trng. Adjustment (See Table 1D)					$ 6,813,146.60		$ 3,642,253.80
Inventory Management Adj. - New FSNs				39	33,150.00		21,319.35
Total Cost Evaluation					$43,868,591.38		$23,593,005.92

(continued)

Table 1E (Cont'd)

SUMMARY OF BID DATA - CASE 1

Item No.	Bid and Evaluation Element		Quantity	BIDDER C Unit Price	Bid	Discount Factor	Present Value
1	600 BHP Diesel	1st yr.	32	$ 24,973	$ 799,136	0.954	$ 762,375.74
		2nd yr.	-	-	-	-	-
		3rd yr.	84	24,973	2,097,732	0.788	1,653,012.82
		4th yr.	84	24,973	2,097,732	0.717	1,504,073.84
		5th yr.	77	24,973	1,922,921	0.652	1,253,744.49
2	600 BHP Diesel w/PTO	1st yr.	8	26,130	209,040	0.954	199,424.16
		2nd yr.	-	-	-	-	-
		3rd yr.	24	26,130	627,120	0.788	494,170.56
		4th yr.	13	26,130	339,690	0.717	243,557.73
		5th yr.	12	26,130	313,560	0.652	204,441.12
3	280 BHP Diesel	1st yr.	8	26,272	210,176	0.954	200,507.90
		2nd yr.	-	-	-	-	-
		3rd yr.	24	26,272	630,528	0.788	496,856.06
		4th yr.	13	26,272	341,536	0.717	244,881.31
		5th yr.	12	26,272	315,264	0.652	205,552.13
12	600 BHP Diesel	1st yr.	2	24,974	49,948	0.954	47,650.39
		2nd yr.	-	-	-	-	-
		3rd yr.	12	24,974	299,688	0.788	236,154.14
		4th yr.	12	24,974	299,688	0.717	214,876.30
		5th yr.	12	24,974	299,688	0.652	195,396.58
15	Engineering Services, Man Days	1st yr.	100	75	7,500	0.954	7,155.00
		2nd yr.	-	-	-	-	-
		3rd yr.	200	75	15,000	0.788	11,820.00
		4th yr.	150	75	11,250	0.717	8,066.25
		5th yr.	150	75	11,250	0.652	7,335.00
18	O/B Repair Parts, Sets	1st yr.	8	4,378.88	35,031.04	0.954	33,419.61
		2nd yr.	-	-	-	-	-
		3rd yr.	19	4,378.88	83,198.72	0.788	65,560.59
		4th yr.	15	4,378.88	65,683.20	0.717	47,094.85
		5th yr.	15	4,378.88	65,683.20	0.652	42,825.45
19	Stock Repair Parts (Table 1B)	1st yr.	1 lot	416,863.82	416,863.82	0.954	397,688.08
		2nd yr.	-	-	-	-	-
		3rd yr.	1 lot	416,863.82	416,863.82	0.788	328,488.69
		4th yr.	1 lot	416,863.82	416,863.82	0.717	298,891.36
		5th yr.	1 lot	416,863.82	416,863.82	0.652	271,795.21
Total Bid Elements					$12,815,498.44		$ 9,676,815.36
ASFC - Item 1 & 2					0.380		
ASFC - Item 3					0.405		
ASFC Adjustment (15 yrs.)							
Engines purchased in:	1st yr.						
	Item 1&2	40			$ 0	7.255	$ 0
	Item 3	8			240,000	7.255	116,080.00
	2nd yr.	-			-	-	-
Note: Present value equals "Bid" divided by 15 and multiplied by "Discount Factor."	3rd yr.						
	Item 1&2	108			0	5.996	0
	Item 3	24			720,000	5.996	287,808.00
	4th yr.						
	Item 1&2	97			0	5.451	0
	Item 3	13			390,000	5.451	141,726.00
	5th yr.						
	Item 1&2	89			0	4.956	0
	Item 3	12			360,000	4.956	118,944.00
Trng. Adjustment (See Table 1D)					$ 8,082,981.00		$ 4,291,730.23
Inventory Management Adj. - New FSNs				63	53,550.00		34,438.95
Total Cost Evaluation					$22,662,029.44		$14,667,542.54

(continued)

Table 1E (Cont'd)

SUMMARY OF BID DATA - CASE 1

Item No.	Bid and Evaluation Element		Quantity	BIDDER D Unit Price	BIDDER D Bid	Discount Factor	BIDDER D Present Value
1	600 BHP Diesel	1st yr.	32	$ 19,614	$ 627,648	0.954	$ 598,776.19
		2nd yr.	-	-	-	-	-
		3rd yr.	84	19,614	1,647,567	0.788	1,298,282.80
		4th yr.	84	19,614	1,647,567	0.717	1,181,305.54
		5th yr.	77	19,614	1,510,278	0.652	984,701.26
2	600 BHP Diesel w/PTO	1st yr.	8	20,244	161,952	0.954	154,502.21
		2nd yr.	-	-	-	-	-
		3rd yr.	24	20,244	485,856	0.788	382,854.53
		4th yr.	13	20,244	263,172	0.717	188,694.32
		5th yr.	12	20,244	242,928	0.652	158,389.06
3	280 BHP Diesel	1st yr.	8	19,196	153,568	0.954	146,503.87
		2nd yr.	-	-	-	-	-
		3rd yr.	24	19,196	460,704	0.788	363,034.75
		4th yr.	13	19,196	249,548	0.717	178,925.92
		5th yr.	12	19,196	230,352	0.652	150,189.50
12	600 BHP Diesel	1st yr.	2	19,614	39,228	0.954	37,423.51
		2nd yr.	-	-	-	-	-
		3rd yr.	12	19,614	235,368	0.788	185,469.98
		4th yr.	12	19,614	235,368	0.717	168,758.86
		5th yr.	12	19,614	235,368	0.652	153,459.94
15	Engineering Services, Man Days	1st yr.	100	80	8,000	0.954	7,632.00
		2nd yr.	-	-	-	-	-
		3rd yr.	200	80	16,000	0.788	12,608.00
		4th yr.	150	80	12,000	0.717	8,604.00
		5th yr.	150	80	12,000	0.652	7,824.00
18	O/B Repair Parts, Sets	1st yr.	8	8,445.73	67,565.84	0.954	64,457.81
		2nd yr.	-	-	-	-	-
		3rd yr.	19	8,445.73	160,468.87	0.788	126,449.47
		4th yr.	15	8,445.73	126,685.95	0.717	90,833.83
		5th yr.	15	8,445.73	126,685.95	0.652	82,599.24
19	Stock Repair Parts (Table 1B)	1st yr.	1 lot	586,988.12	586,988.12	0.954	559,986.67
		2nd yr.	-	-	-	-	-
		3rd yr.	1 lot	586,988.12	586,988.12	0.788	462,546.64
		4th yr.	1 lot	586,988.12	586,988.12	0.717	420,870.48
		5th yr.	1 lot	586,988.12	586,988.12	0.652	382,716.25
Total Bid Elements					$11,303,831.09		$ 8,557,400.63
ASFC - Item 1 & 2					0.420		
ASFC - Item 3					0.510		
ASFC Adjustment (15 yrs.)							
Engines purchased in:	1st yr.						
	Item 1&2	40			$ 2,400,000	7.255	$ 1,160,800.00
	Item 3	8			1,248,000	7.255	603,616.00
	2nd yr.	-			-	-	-
Note: Present value equals "Bid" divided by 15 and multiplied by "Discount Factor."	3rd yr.						
	Item 1&2	108			6,480,000	5.996	2,590,272.00
	Item 3	24			3,744,000	5.996	1,496,601.60
	4th yr.						
	Item 1&2	97			4,020,000	5.451	1,460,868.00
	Item 3	13			2,028,000	5.451	736,975.20
	5th yr.						
	Item 1&2	89			5,340,000	4.956	1,764,336.00
	Item 3	12			1,872,000	4.956	618,508.80
Trng. Adjustment (See Table 1D)					$ 8,261,381.60		$ 4,352,788.00
Inventory Management Adj. - New FSNs			47		39,950.00		25,692.55
Total Cost Evaluation					$46,737,162.69		$23,367,858.78

DISCUSSION

This Case clearly shows the effect of the inclusion of significant life cycle costs. Ranking the discounted bids before considering LCC elements, the order of the bidders would be:

D (winner)
C
B
A

However, LCC changes the ranking to:

C (winner)
D
B
A

with Bidder C the clear winner (about one-half the LCC cost of A) whereas, in the original bidding, Bidders B, C, and D were quite close.

The most important LCC element in this Case is fuel. This would suggest that those equipments which consume fuels or other material and have a relatively long expected life (in this case, 15 years) are prime candidates for LCC consideration.

Note the differences in the equations for life cycle cost determination and penalty determination in Sections 1 and 3, respectively, of the discussion of Average Specific Fuel Consumption (under "materials"). It is important that the penalty is not so great that the risks overwhelm the profit potential on a contract. Thus, some leeway is granted in the test determination of ASFC and the penalty covers only one year's operation. Care must be taken in establishing the penalties for operations of equipments with a long expected life and where operating costs

become a highly significant part of the total life cycle costs. For further discussion of price adjustment provisions, refer to the DoD Life Cycle Costing Procurement Guide.

Training costs were not used in the actual procurement because the cost factors were not sufficiently developed at that time and bases were not identified. In this Case, addition of training costs did not alter the award decision. However, the magnitude and possible variation of life cycle training costs indicate that they should be considered for equipments which require a complete course. If the equipment training were covered in a lecture or shop period within a more general course, the costs would include only manual and guide changes and probably would be too small to consider in any great depth.

On large quantity procurements, inventory management costs are a relatively small item and may be insignificant, since they apply on total contract rather than unit costs.

It is not in the Government's interest nor equitable to contractors to make price adjustments based on individual LCC elements when the total LCC using tested parameter values is equal to or less than the total LCC proposed by the contractor <u>when the equipment proposed to be delivered to the Government satisfies specified individual parameter values</u>. For example, assume that (i) a solicitation specifies a minimum acceptable MTBF of 200 hours and a maximum useful MTBF of 500 hours, and the award was based on a proposed MTBF of 400 hours, (ii) the contract reflects the same specifications regarding minimum and maximum MTBF as the solicitation, (iii) the offeror proposed to limit additional new items entering the inventory to 5, and (iv) the equipment delivered has 450 hours MTBF and requires the Government to take 15 new parts into the inventory.

In these circumstances, because the improved MTBF exceeds that which was proposed and is within the specified range, the total measured LCC may be less than that which was computed in the original award evaluation. If this is so, it would not be fair and equitable to require a price adjustment because the number of new parts entering the inventory exceeds the number proposed. On the other hand, price adjustment should be applied if the measured total LCC exceeds the proposed LCC or the equipment is not within the specified range of individual parameter values. In all circumstances when computing measured total LCC, the values used will not exceed the upper limits of the values in the specified range.

CASE 1

APPENDIX A

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MIL-E-23457A (SHIPS)
4 January 1965

MILITARY SPECIFICATION (MODIFIED)

ENGINES, DIESEL, PROPULSION AND

AUXILIARY, NAVAL SHIPBOARD

1. SCOPE

1.1 Scope. - This specification covers propulsion and auxiliary diesel engines for use aboard ships, boats and landing craft.

1.2 Classification. - Engines shall be of the following types, as specified (see 6.1):

Type A - Diesel engines for ship propulsion and auxiliary units.
Type B - Commercial diesel engines for ship, landing craft and boat propulsion and auxiliary units.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

F-P-666 - Prime, Pressure, Internal Combustion Engine (Cold Starting Aid) and Primer Cartridges.
O-A-548 - Antifreeze, Ethyline Glycol, Inhibited.

MILITARY

MIL-R-196 - Repair Parts for Internal Combustion Engines, Packaging of.
MIL-J-5624 - Jet Fuel, Grades JP-4 and JP-5.
MIL-F-7194 - Filters, Engine Charge Air.
MIL-L-9000 - Lubricating Oil, Internal Combustion Engine, Diesel.

MIL-M-9868 - Microfilming of Engineering Documents, 35 MM, Requirements for.
MIL-M-10304 - Meters, Electrical-Indicating, Panel Type, Ruggedized.
MIL-M-15071 - Manuals, Equipment and Systems.
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-M-15337 - Mufflers, Exhaust, Internal Combustion Engine.
MIL-S-15371 - Starter, Engine, Electrical (Naval Shipboard Use).
MIL-H-15424 - Hand Tools, Packaging of.
MIL-C-15730 - Coolers, Fluid, Industrial, Naval Shipboard; Lubricating Oil and Fresh Water.
MIL-S-10032 - Switches, Pressure and Thermostatic, Naval Shipboard Alarm System.
MIL-I-16049 - Tachometers: Electrical; Self-Generating; Mechanical, Fixed Mounting and Hand Held; and Vibrating Reed.
MIL-I-16165 - Interference Shielding, Engine Electrical Systems.
MIL-C-16173 - Corrosion Preventive, Solvent Cutback, Cold Application.
MIL-P-16298 - Electric Machines Having Rotating Parts and Associated Repair Parts: Packaging of.
MIL-P-16304 - Pyrometers, Indicating.
MIL-P-16789 - Preservation, Packaging, Packing and Marking of Pumps, General and Associated Repair Parts.
MIL-F-16884 - Fuel Oil, Diesel, Marine.
MIL-T-17244 - Thermometer, Self-Indicating, Bimetallic, Shock-Resistant.
MIL-P-17286 - Propulsion and Auxiliary Steam Turbines and Gears (Including Repair Parts, Tools, Accessories and Instruments); Packaging of.
MIL-E-17555 - Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.

MIL-C-18438 - Chargers, Battery, Generator Type.
MIL-G-18997 - Gages, Pressure, Dial Indicating, Bourdon Tube Circular Face.
MIL-T-19646 - Thermometers, Remote Reading, Self-Indicating Dial, Gas-Actuating.
MIL-C-19713 - Coolers, Fluid, After Air, Diesel Engine, Naval Shipboard.
MIL-F-20042 - Flanges, Pipe Bronze (Silver Brazing).
MIL-F-20627 - Filter Assembly and Filter Elements, Fluid, Pressure (For Engines With Liquid Fuel Injection Systems).
MIL-F-20670 - Flanges, Pipe, Carbon Steel, 150 PSI, W.S.P. (For Naval Shipboard Use).
MIL-F-20707 - Filter Elements, Fluid, Pressure; Oil, Full Flow.
MIL-C-21121 - Coolers, Fluid, Industrial; Lubricating Oil and Fresh Water, Naval Shipboard.
MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative.
MIL-F-21467 - Fittings, Flareless, Fluid Connection (Shipboard Use).
MIL-C-22109 - Contactors and Controllers, Electrical Engine Starting, Naval Shipboard Use.

STANDARDS

MILITARY

MIL-STD-130 - Identification Marking of U. S. Military Property.
MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-740 - Noise Measurements of Shipboard Machinery and Equipment.
MS35802 - Filter Elements, Fluid, Pressure-Oil, Full-Flow.

DRAWINGS

BUREAU OF SHIPS

810-1385850	- Piping, Gage, for all Service.
5000-S4501-64492	- Arrangement for Lube Oil and Jacket Water Coolers for Internal Combustion Engines.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. - The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, New York, 10016).

3. REQUIREMENTS

3.1 General requirements for all engines. -

3.1.1 Engine and rating. - Unless otherwise approved by the bureau or agency concerned, the engine shall be of a type which has been satisfactory in Navy or commercial use at or comparable to the rating required. The engine shall be capable of continuous operation under standard operating conditions at the brake horsepower (BHp) and revolutions per minute (r.p.m.) specified (see 6.1) without excessive exhaust smoke or temperature under the standard operating conditions specified in 3.1.1.1. For the purpose of standardization all engines shall have a continuous rating of 600 BHP at 2000 to 2300 RPM and shall be adjusted for and tested at the 600 BHP rating with the exception of the ship's service generator engines (Item 3). The ship's service generators shall be rated at a BHP corresponding to a 185 KW generator output.

3.1.1.1 Standard operating conditions. - Unless otherwise specified (see 3.3.1 and 6.1) the following standard operating conditions shall be used for design of the engine and accessories:

Ambient air temperatures.	100°F.
Barometric air pressure (dry) . .	29 inches mercury (Hg).
Fresh water from engine	160°F (minimum) - 185°F (maximum).
Lubricating oil from engine . . .	160°F (minimum) - 180°F (maximum).
Exhaust back pressure	1 inch Hg.
Sea water inlet temperature . . .	85°F.
Sea water outlet temperature. . .	130°F (maximum).

3.1.2 Weight and dimensions. - The dimensions and weight shall be as specified in 3.1.2.1 and 3.1.2.2.

3.1.2.1 Weight. - The wet weight of the complete engine with all specified attached accessories shall not exceed 4800 pounds.

3.1.2.2 Dimensions. - The engine dimensions complete with all specified attached accessories shall not exceed the following:

Length (Overall)	88"
Length(Flywheel housing to forward extremity)	80"
Width (Overall)	46"
Height (Overall)	61"

3.1.3 Shock resistance. - When specified (see 6.1) the engine shall be designed to meet the requirements of the Appendix to this specification. The engines shall be High Impact shock resistant conforming to the Appendix. The Contractor shall make necessary arrangements for shock testing with the shock laboratories. The Bureau will furnish on written request, a list of certified commercial and Government owned shock test machines available for use in various Canadian and U.S. geographic areas. A test report certified by the U.S. Government representative shall be submitted for Bureau approval.

3.1.4 Resiliently mounted equipment. - Systems will be designed for resilient mounting and the following data shall be furnished on a drawing headed "Mounting Installation Design Data." Only that data pertinent to the engines will be furnished.

(a) Speed range (for propulsion machinery and direct (d.c.) current generators) or synchronous speed (for alternating current (a.c.) generators) of the unit.
(b) Total weight of the mounted assembly in the operating condition. The weight should include weight of subbase, service fluids, piping, filters and all other attached accessories.
(c) Location of the unit center of gravity in at least two planes.
(d) The moments of inertia and products of inertia of the mounted unit about three mutually perpendicular axis with the origin at the unit center of gravity and the orientation of the axis indicated with respect to the equipment and ship.
(e) The six natural frequencies (in cycles per second (c.p.s.)) of the unit.
(f) The type mounting used in performance of the calculations. For mountings other than approved Navy type, information relative to mount natural frequency, static load deflection and transmissability is required.
(g) List of assumptions made in calculating natural frequencies.

3.1.5 Inclination. - The engine and accessory components, including piping systems shall be designed to operate satisfactorily and without loss of fluids or connecting rod and timing gear dipping under conditions specified in 3.2.4 and 3.3.2.

3.1.6 Torsional vibration. - The engine shall furnish a torsional vibration analysis in accordance with MIL-STD-167 except that the actual torsiograph test is not required in cases where the engine manufacturer does not furnish the engine driven equipment. WR2 and coupling and shafting stiffnesses shall be furnished by the Bureau on request. Since there are two different manufacturer's pulse generators in use as well as different applications, torsional analyses will be required for each arrangement and generator type.

3.1.7 Aluminum parts. - Aluminum parts, other than pistons, blowers and fuel pumps, shall be protected from corrosion by one of the following methods:

(a) Exterior parts to be painted shall be anodized or treated with corrosion resistant chemical film.
(b) Exterior parts to be left unpainted shall be anodized.
(c) Interior parts in contact with oil do not require treatment.
(d) Interior parts not in contact with oil, shall be anodized or treated with a corrosion resistant chemical film.

3.1.7.1 Threaded holes in aluminum intended for bolts or screws for components or accessories normally removed or disassembled during routine maintenance or inspection shall have steel inserts. Where insufficient basis metal exists, studs may be used without inserts.

3.1.8 Magnesium alloys. - Magnesium alloys shall not be used.

3.1.9 Accessory equipment. - The following accessories shall be furnished with each engine. Depending on the particular installation, additional accessory requirements shall be as specified (see 3.2.1, 3.3.3. and 6.1).

(a) Sea water pump
(b) Fresh water pump
(c) Lubricating oil pressure pump
(d) Fuel supply pump
(e) Lubricating oil cooler
(f) Fresh water cooler
(g) Lubricating oil filter(s)
(h) Lubricating oil strainer
(i) Intake air silencer
(j) Intake air cooler (if turbocharged)
(k) Fuel oil filter
(l) Fuel oil strainer
(m) Temperature regulator or thermostat
(n) Governor
(o) Starting equipment (less air tanks or batteries)
(p) Blower or turbocharger
(q) Engine mounted controls
(r) Onboard repair parts
(s) Special tools

Other accessories or engine attached piping necessary for satisfactory engine operation but which are not specified herein or in the contract or order shall be furnished by the engine manufacturer. Unless otherwise specified, piping, including fittings and flanges, alarm systems, wiring, or mechanical linkage required to connect detached accessories, instruments, and controls to the engine, or to cooling water, fuel, starting air, electrical, exhaust, or lubrication systems, will be furnished by the installing activity.

3.1.10 Guards and shields. - Guards and shields shall be furnished to the extent specified in 3.1.10.1 and 3.1.10.2.

3.1.10.1 Guards. - Guards for protection of personnel shall be provided for flywheels and other exposed moving parts. Where there are no feasible means for attaching the guard to the equipment, they shall be provided by the installing activity.

3.1.10.2 Shields. - All hot machinery surfaces shall be shielded or lagged so that no external surface of the machinery shall exceed a temperature of 450°F. All fuel and lubricating oil lines or fittings, including gage lines, shall be located or shielded so that any leaks cannot drip or spray on exhaust system components.

3.1.11 Timing marks. - Means shall be provided to permit checking of valve and injection pump timing.

3.1.12 Crankshaft. - The engine shall be furnished with a flywheel fitted with a flexible drive plate and a stainless steel spool piece to adapt the engine to the present generator shaft flexible coupling. Details of the spool piece will be furnished by the Bureau of Ships 60 days after receipt of the engine installation plan. Provision shall be made on the free end of the crankshaft of all engines for accommodating a torsiograph drive, a hand tachometer, and/or a power take-off. The power take-off shall be furnished on only (1) of each (6) or (7) engines and shall be capable of delivering approximately 40 to 50 horsepower. The power take-off will drive an emergency firepump and under normal conditions will not be used simultaneously with other engine operations. The power take-off shall be equipped with a mechanically actuated clutch. It shall be adaptable to all other engines with a minimum of modification. Detailed dimension drawings of the power take-off shall be submitted with the preliminary installation drawings.

3.1.13 Designating and marking. - Engines, components and parts shall be marked for identification in accordance with

MIL-STD-130. Engines shall be provided with an identification plate secured to the engine in a visible location preferably on the cylinder block. Identification plates shall be of metal and shall show the following:

(a) Engine type
(b) Serial numbers
(c) Federal stock numbers
(d) Contract number
(e) Model number
(f) R.P.M.
(g) BHp
(h) Rotation
(i) Bore
(j) Stroke

3.1.13.1 A plate with an arrow showing the direction of rotation shall be secured to the engine at the power take off end of the engine. For reversing engines, the arrow shall indicate the ahead direction of rotation for the primary power takeoff.

3.1.13.2 Repair parts shall be marked with the manufacturer's part number by casting, stamping or etching. Where it is not practical to mark parts by any of these methods, the parts shall be identified by tags or printed description on the package.

3.1.14 Accessibility. - Engine attached accessories such as pumps, blowers, coolers, filters, strainers and silencers, shall be designed and secured in such a manner as to permit maximum accessibility to the accessories and the engine (see 3.2.2).

3.1.15 Piping systems. - Engine attached piping shall be strapped and supported by the engine structure to prevent vibration and resist shock. Pipe couplings of the hose type or lengths of nonmetallic composition tubing may be used when installed in a visible and accessible location. Takedown joints in fuel systems shall be kept to a minimum to reduce leaks. Flange connections may be either commercial or Navy type. If commercial flanges are supplied, each connection to ships piping shall be provided with a companion flange. Navy type companion flanges are not required. Navy type flanges for steel or nonferrous piping and fittings shall conform to MIL-F-20670 or MIL-F-20042, as applicable (see 3.2.5 and 3.3.6).

3.1.15.1 Fuel system. - Engines shall be suitable for operation on diesel fuel corresponding to MIL-F-16884 or grade JP-5 of MIL-J-5624. The fuel system shall include the following:

(a) Positive displacement type supply pump.
(b) Relief valve connected to discharge to pump suction or supply tank.
(c) Filters.
(d) Strainers.
(e) Necessary piping, valves and fittings.

3.1.15.1.1 Fuel filter and strainer. - The filter shall conform to MIL-F-20627 and shall be of the simplex type. The filter shall be installed between the engine driven fuel pump and injection pump. Strainers, primary or secondary, shall be of the simplex metal edge type, with 0.003 - 0.0035 inch spacings, enclosed manual cleaning knives and sediment drain valves. The strainer case shall be of brass, bronze or other metal which is not readily corroded by sea water contaminated fuel oil.

3.1.15.1.2 Fuel pumps. - The engine driven positive displacement fuel pump shall be capable of lifting the fuel a minimum of 48 inches.

3.1.15.2 Lubricating oil system. - Lubricating oil shall conform to Military symbol 9250 of MIL-L-9000, for ambient conditions above 20°F. The same grade or symbol number of lube oil shall be used in the engine, accessories and transmission. Engines shall be provided with an oil level indicator, filling opening and accessible sump drain connection or suitable sump pump to drain or clean the engine oil pan (see 3.2.5.2 and 3.3.6.1).

3.1.15.2.1 Lubricating oil pumps. Pressure pumps, scavenging pumps and piston cooling pumps shall be of the positive displacement type, driven by the engine. For standardization purposes, all engines shall be provided with a drive and mounting boss for a lubricating oil scavenging pump to return oil from the generator pedestal to the engine sump. The pump drive shall be enclosed by a cover plate. Also a connection shall be provided for supplying approximately 1 gpm of lube oil to a generator at 9-10 psi. Oil temperature to the generator shall be between 140 and 150°F. A separate oil cooler is acceptable to meet this requirement, if needed. A relief

valve shall be provided for the outlet of each pump. If the oil pump suction incorporates a check valve, means shall be provided to prevent excessive pressure build up in the suction line in case the engine and pump are rotated backward.

3.1.15.2.2 Lubricating oil coolers. - Coolers shall conform with 3.3.6.1.1 and shall be engine mounted.

3.1.15.2.3 Lubricating oil filters and strainers. - Filters and strainers shall be furnished as specified in 3.2.5.2.1 and 3.3.6.1.2.

3.1.15.3 Cooling water system. - Engines shall be designed to operate with a closed fresh water cooling system (see 3.2.5.3 and 3.3.6.2).

3.1.15.3.1 Cooling water pumps. - Unless otherwise specified (see 3.3.6.2.2), fresh and sea water pumps shall be of the centrifugal type driven by the engine. Where practicable, the fresh and sea water pumps shall be interchangeable. If necessary, water pumps shall be provided with a continuous vent located at the upper part of the casing. Pump drive arrangements shall be designed to prevent water leakage into the engine lubrication system. Pumps for direct reversing engines shall be designed to operate in either direction, for type A engines. All pumps shall be provided with drain cocks. Type B engine pumps may be drained by breaking a pipe connection. The engine technical manual shall contain instructions for completely draining the pumps. The sea water pump shall be of sufficient capacity to supply a reduction gear lube oil cooler and a generator air cooler in addition to the engine jacket water cooler and intercooler. Requirement for the pump is approximately 60 gpm, 10 psi at the pump discharge at 85°F, over that normally required for the engine and intercooler. Sea water pumps may be of the centrifugal type. Also when specifically approved by the Bureau, pumps may be belt driven and detached from the engine. In this event the contractor shall furnish dimensioned detail drawings showing arrangement, mounting features, belt sizes as well as any other pertinent information required by the boatbuilder."

3.1.15.3.2 Heat exchangers. - Heat exchangers shall conform to paragraph 3.3.6.2.1.

3.1.15.3.3 Temperature regulator and thermostat. - Temperature regulating valves and thermostatic valves shall be either the frail safe type which will pass all the cooling water through the cooler in the event of failure of the thermostatic element, or be provided with a manual "over-ride" for the thermostatic element. Valves shall be furnished as specified in 3.2.5.3 and 3.3.6.2.

3.1.15.3.4 Gaskets and packing. - Gaskets and packing in the cooling water system shall be of material resistant to deterioration when anti-freeze compound conforming to O-A-548 or preservative compound conforming to MIL-C-16173, and MIL-L-21260.

3.1.16 Starting system. - Engines shall be started by means of an air motor. The motor shall be designed for operation on air supplied at 100 psig. Starting air tanks, reducing valves, filters, lubricators, and piping to the motor shall be furnished by the installing activity.

3.1.16.1 Extreme cold starting. - When specified (see 3.3.4 and 6.1) engines shall be capable of being started at a temperature of minus 20°F. Ether primer cold starting aids, if used, shall conform to F-P-666.

3.1.17 Exhaust systems. - Exhaust headers shall be fresh water cooled. When approved by the bureau or agency concerned, lagged or heat shielded exhaust headers are acceptable. Engine exhaust outlets shall be either at the main power take-off end or center of the engine. Outlets, shall be arranged for a vertical exhaust system. Means shall be provided for installing a ship builder furnished exhaust manifold pyrometer.

3.1.18 Governors. - Unless otherwise specified in the contract or order, engines shall be equipped with a speed governing system and independently driven overspeed governor. Governor type shall be as specified (see 3.3.8 and 6.1).

3.1.18.1 Type I governors. - Type I governors shall be furnished for constant speed engines.

3.1.18.1.1 Steady-state stability. - When operating at all loads up to rated load, the speed for any constant load shall be so controlled that the periodic or aperiodic oscillations of speed shall be not greater than plus or minus 0.50 percent of rated speed.

3.1.18.1.2 Momentary speed surge. - The response of the governor shall be such that upon sudden application or loss of rated load, the maximum momentary decrease or increase in speed shall not exceed 7 percent of rated speed. In addition, the engine r.p.m. shall return to and remain within 1 percent of the final steady state speed in not more than 5 seconds following a change in load.

3.1.18.2 Type II governors. - Type II governors shall be furnished for variable speed engines as specified in the contract or order.

3.1.18.2.1 Steady-state stability. - When operating at all speeds and loads up to rated load and speed the periodic or aperiodic oscillations of speed shall be not more than plus or minus 1.0 percent of operating speed.

3.1.18.2.2 Momentary peed surge. - The maximum deviation from normal speed, when full or partial rated load is applied or removed suddenly, shall not exceed 10 percent of operating speed. The speed shall return to plus or minus 1 percent of operating speed in not more than 15 seconds following the change in load.

3.1.18.3 Type I and II governors. - Governors for engines which are required to operate in parallel on a single propulsion shaft system shall be provided with a load limiter or fuel stop which will automatically control engine torque to a safe limit. Regulating governors shall be provided with a steady-state speed regulation mechanism, adjustable from 0 to 5.0 percent of rated speed.

3.1.18.4 Overspeed governors. - When required (see 6.1) overspeed governors shall prevent the engine from exceeding rated speed by more than 15 percent by cutting off completely the fuel or air to the engine. The overspeed governors shall be of the automatic resetting type.

3.1.18.5 Delete.

3.1.19 Air intake system. - The engine blower or intake air header shall be fitted with an air silencer and suitable filter or screen. When specified (see 6.1) engines shall be provided with a filter in accordance with MIL-F-7194. The filter will be required for installations where a three way valve is

installed to permit engines to take air from either the engine room or the weather. The filter and elements shall be designed to withstand a uniformly distributed pressure of 5 pounds per square inch (psi) over the entire surface of the element. The area of the filter element shall be such that the air velocity at the face of the filter does not exceed 2000 feet per minute, or the pressure drop across the clean filter be more than 4 inches of water at rated output. A manometer or signal device shall be connected across the element to indicate when cleaning is required. The filter housing shall permit removal of the element for cleaning. The filter element shall be installed at an angle perpendicular to or less than 90 degrees to the direction of air flow in order that impinging dirt will drop to the bottom of the duct on the upstream side of the filter element. Intercoolers shall be cooled with sea water.

3.1.19.1 Blowers and air receivers. - Means shall be provided for draining pockets in the blower housing and air receiver where oil or water may accumulate.

3.1.20 Instruments. - Instruments shall be furnished as specified in 3.2.7 and 3.3.10. When furnished, electrical instruments shall be of the two wire ungrounded type.

3.1.21 Controls. - Controls shall be furnished as specified in 3.2.8 and 3.3.12.

3.1.21.1 Emergency shutdown device. - Unless otherwise specified (see 3.3.12 and 6.1) engines shall be provided with an emergency shutdown device, operable by a pull cable, which will trip the fuel racks or shut off the air and stop the engine within 60 seconds. The pull cable will be furnished by the installing activity and shall be operable from a location adjacent to the access to engine compartment. The device shall be of a type which requires manual resetting before the engine can be restarted.

3.1.23 Painting. - After completion of engine tests and prior to shipment, all external surfaces of ferrous metal of type A engines shall be cleaned and painted with one coat of zinc chromate, aluminum paint or other suitable metallic primer. Type B engines shall be painted in the same manner as for commercial delivery.

3.1.24 Non-magnetic material. - Material with a magnetic permability not greater than 2.0 in the finished condition shall be employed in the fabrication of the following:

(a) Cylinder block and covers
(b) Oil pan or sump
(c) Flywheel housing and covers
(d) Exhaust manifold and elbows
(e) Front cover, engine supports and mounts
(f) Flywheel (excluding ring gear) and flex plate
(g) End plates (front and rear)
(h) Pulleys
(i) Power take-off housing
(j) Heat exchanger housing, elbows and supports
(k) Lubricating oil cooler housing(s), covers
(l) Vibration damper and hub
(m) Oil pump (Shafts, gears, inlet and outlets)
(n) Thermostat housing and covers
(o) Blower housing, rotors and drive supports
(p) Engine breather housing
(q) Rocker shaft brackets, lifter brackets and rocker shaft
(r) Fuel pump
(s) Oil filter housings, heads, standpipes and brackets
(t) Turbocharger and supports (except bearings, shafting other high wear resistance parts)
(u) All external nuts, washers, bolts, studs and cap-screws
(v) Governor housings
(w) Miscellaneous tubes, fittings and piping

The magnetic envelope shall be maintained at a minimum, therefore, overhanging equipment and brackets as well as other appendages shall be made of non-magnetic material. Deviations from the above specified list shall be substantiated. The contractor shall submit a certified itemized list of non-magnetic and magnetic parts to be furnished. This list shall include:

(a) Part Name
(b) Part Number and/or drawing number
(c) Material
(d) Weight
(e) Box dimensions (L.W.H, or Diam, D) (FOR MAGNETIC PARTS ONLY)

The list shall be totaled and shall include the ratio of non-magnetic material to total dry weight of the engine. The list shall be submitted along with longitudinal and athwartship vertical cross section drawings. The magnetic material shall be shaded on these drawings.

3.3 Specific requirements for type B engines:

3.3.1 Standard operating conditions. - Unless otherwise specified (see 6.1), the following requirements apply to type B engines only:

(a) Lubricating oil from engine or in sump.....160°F (minimum) - 240°F (maximum)
(b) Lubricating oil to engine or in the gallery.....225°F (maximum)
(c) Operating time between oil changes.....100 hours (minimum)

3.3.2 Inclination. - Engines shall operate in accordance with the requirements of 3.1.5 under the following conditions:

(a) When the ship is permanently trimmed down by the bow or stern up to 5 degrees from the normal horizontal plane.
(b) When the ship is permanently listed up to 10 degrees to either side of vertical.
(c) When the ship is rolling up to 45 degrees to either side of vertical.
(d) When the ship is pitching 10 degrees up or down from the normal horizontal plane.

3.3.6 Piping systems.

3.3.6.1.1 Lubricating oil coolers. - Lubricating oil coolers for type B engines shall conform to either MIL-C-15730 or MIL-C-21121 except that hose connections are acceptable and the HI-shock resistance, repair parts and drawing provisions do not apply. These requirements do not preclude the use of other coolers which are presently in satisfactory Navy use or when specifically approved by the Bureau. Coolers shall be engine mounted.

3.3.6.1.2 Lubricating oil filters. - Lubricating oil filters for type B engines shall be of the full flow type accepting elements conforming to MIL-F-20707 and MS35802. Relief valves may be internal and shall be so designed that sump sediment will not discharge into the engine oil system when starting a cold engine. Filters and strainers shall be engine mounted.

3.3.6.2 Cooling system. - For type B propulsion engines, the temperature of the engine circulating water shall be controlled automatically by means of an engine mounted bypass type thermostatic valve. Operating temperatures shall be as specified in 3.1.1 and 3.3.1.

3.3.6.2.1 Heat exchangers. - Unless otherwise specified (see 6.1), heat exchangers for type B engines shall be mounted on the engine. Heat exchangers shall conform to either MIL-C-15730 or MIL-C-21121, except that hose connections are acceptable and the HI-shockresistance, repair parts and drawing provisions do not apply. These requirements do not preclude the use of other heat exchangers which are presently in satisfactory Navy service or when specifically approved by the Bureau. Heat exchangers and expansion tanks shall be mounted on the engine.

3.3.6.2.2 Cooling water pumps. - Sea water pumps for type B engines shall be of the positive displacement type.

3.3.8 Governor. - Governors for all engines shall conform to Type II requirements of 3.1.18.2 through 3.1.18.3. Paralleling requirements are as follows: When operating on a repetitive duty cycle of 5½ seconds ON forward polarity, 9½ seconds OFF, 5½ seconds ON reverse polarity, 9½ seconds OFF, the current (I) of each of the three generators shall build up to maximum value (Im) in not more than 0.8 seconds after initiation of ON time, and shall decay to zero current in not more than 0.7 seconds after initiation of OFF time. Over-shoot during buildup and decay shall not be greater than 6% (of Im) and deviation from zero current during OFF time shall be not more than 30 amperes per generator. (Im) shall be determined from the relationship.

$Im = 1/3\sqrt{\frac{3KW \times 10^3}{R}}$ where KW is the maximum kilowatt output per generator provided by a 500 BHP engine operating within the permissible speed range of the engine generator set on the

5½ second ON, 9½ second OFF load cycle, and R = 0.05 ohm. Satisfactory operation will be demonstrated by the installing activity by oscillograms of the current of each generator, terminal voltage, speed of each generator and time taken simultaneously on a multi-channel oscillograph.

3.3.10 Instruments, panels and alarms. - The following instruments shall be furnished for each engine:

(a) Pressure gages

(1) Sea water pump discharge
(2) Lubricating oil pump discharge
(3) Fuel oil pump discharge and filter outlet (Duplex)
(4) Airbox or air manifold pressure

(b) Thermometers

(1) Fresh water from engine
(2) Lubricating oil sump

(c) Tachometer (mechanical)

3.3.10.1 - Instrument dials shall be white or silver with black numerals. All gages shall be of the flush mounted type. All pressure and temperature gages with capillaries and the tachometer will be furnished loose for installation on a shipbuilder supplied gage board for mounting at the forward end of the engine. The board will be secured to the engine by means of vibration isolation fittings. Tachometers shall be mechanical conforming to MIL-T-16049.

3.3.10.2 Alarms. - A 3/8 inch IPS thread shall be provided at the remote end of the lubricating oil distribution system for later installation of a low lubricating oil pressure alarm contactor. Space shall be provided for installing a high temperature alarm contactor actuating bulb with a ½ inch IPS thread in the fresh water outlet header from the engine. Holes shall be closed by pipe plugs.

3.3.12 Controls. - Engines shall be such that the shipbuilder may connect either of the following control systems:

(1) Engine mounted mechanical start, speed and stop controls: Necessary controls shall be mounted on a bracket which can be bolted to the right side, front end or the engine (viewed from the front end of the engine facing aft). Bracket and controls (including any necessary cable, connections, etc.) shall be shipped loose for engine mounting by the shipbuilder. The engine manufacturer shall furnish two sets of controls with each engine furnished under Item 3 covered by the FY 1966 procurement and three sets of controls with each engine furnished under Item 3 covered by FY 1968 thru FY 1970 procurements.

(2) Pneumatic speed control from the pilot house and pneumatic start, speed and stop control from a remote operating station in the engine room. Only engine mounted components of the control system shall be furnished by the engine manufacturer. Emergency shutdowns shall comply with paragraph 3.1.21.1. Pull cable and emergency stop control handle shall be furnished by the shipbuilder.

3.4 Repair parts and tools.

3.4.1 Onboard repair parts. - Unless otherwise specified (see 6.1) onboard repair parts for each ship or boat shall be furnished in accordance with table I. Parts expressed in percent are based on requirements for one engine.

Table I - Onboard repair parts

Part designation	Parts required		Number of engines installed per ship					
	Type A	Type B	1	2	3	4	6	8
Cylinder head assembly[1/]	Yes	Yes	1	1	2	2	3	4
Connecting rods, complete with bolts, nuts and bearings[1/]	Yes	Yes	1	1	1	2	2	3
Piston assembly complete with bushings, wrist pin and retainers	Yes	Yes	1	1	2	2	3	4
Cylinder liners	Yes	Yes	1	1	2	2	3	4
Piston rings	Yes	No	10%	20%	30%	60%	100%	100%
Wrist pin	Yes	No	1	1	2	2	3	4
Crankpin bearing shells	Yes	Yes	20%	40%	60%	80%	120%	200%
Main bearing shells each size[1/]	Yes	Yes	1	1	1	2	2	2
Main bearing bolts[1/]	Yes	No	2	2	3	4	6	8
Thrust bearing shells	Yes	Yes	1	1	1	2	2	3
Exhaust valves	Yes	Yes	4	8	12	12	16	20
Air inlet valves	Yes	Yes	2	2	4	6	8	12
Springs, inlet valve	Yes	Yes	2	2	4	6	8	12
Springs, exhaust valve	Yes	Yes	2	2	4	6	8	12
Valve guides, keys and locks[1/]	No	Yes	20%	40%	60%	80%	120%	200%
Fuel injectors or nozzles	Yes	Yes	25%	50%	75%	100%	150%	200%
Fuel injector spray tips	Yes	Yes	50%	100%	150%	200%	300%	400%
Fuel injector needles and guides	Yes	Yes	25%	50%	75%	100%	150%	200%
Fuel injector pump assembly or unit injector	Yes	Yes	20%	40%	60%	80%	100%	120%
Fuel pump plungers and barrels	Yes	Yes	20%	40%	60%	80%	100%	120%
High pressure fuel lines	Yes	Yes	2	4	6	8	12	16
Electric starting motors and controls	Yes	Yes	See MIL-S-15371					
Fuel filtering elements	Yes	Yes	200%	400%	600%	800%	1200%	1600%
Lube oil filtering elements	Yes	Yes	200%	400%	600%	800%	1200%	1600%
Air starting check valves[1/]	Yes	No	1	2	3	3	4	6

[1/] Parts are not required for emergency generator sets.

Table I - Onboard repair parts (Continued)

Part designation	Parts required		Number of engines installed per ship					
	Type A	Type B	1	2	3	4	6	8
Air starting distributor valve[1/]	Yes	No	0	1	1	1	1	2
Air reducing valve parts (set)[1/]	Yes	No	0	1	1	1	1	2
Camshaft bearing on each size[1/]	Yes	No	1	1	1	2	2	2
Governor regulating complete[1/]	Yes	Yes	0	1	1	1	1	1
Governor overspeed complete[1/]	Yes	Yes	0	0	1	1	1	1
Lubricating oil pressure pumps complete[1/]	Yes	Yes	0	1	1	1	1	1
Lube oil scavenging or piston cooling pump complete[1/]	Yes	Yes	0	1	1	1	1	1
Fresh water pump complete[1/]	Yes	Yes	0	1	1	1	1	1
Sea water pump complete[1/]	Yes	Yes	0	1	1	1	1	2
Fuel oil supply pump	Yes	Yes	1	1	1	1	2	2
Flexible drive coupling parts[1/]	Yes	Yes	0	1	1	2	2	3
Tachometer magneto[1/]	Yes	No	1	1	1	1	2	2
Tachometer, mech., with shaft[1/]	Yes	Yes	0	1	1	1	1	1
Pressure gages (one of each size)[1/]	Yes	Yes	0	1	1	1	2	2
Thermometers (one of each type)[1/]	Yes	No	1	1	1	1	2	2
Safety and relief valve parts for each type and size valve[1/]	Yes	Yes	0	1	1	1	2	2
Gears accessory drive (small)[1/]	Yes	Yes	0	1	1	1	2	2
Blower and/or turbocharger complete	Yes	Yes	0	1	1	1	1	1
Springs, assorted sizes (sets)	Yes	Yes	1	1	1	1	1	1
Bushings, wearing parts (sets)	Yes	Yes	1	1	1	2	2	2
Cooler parts	Yes	Yes	See MIL-C-15730 and MIL-C-19713					
Gaskets, packing and seal (sets)	Yes	Yes	1	1	2	2	3	4
Ball and roller bearings each size	Yes	Yes	1	1	1	1	2	2
Assorted non-standard bolts and nuts	Yes	Yes	1	1	1	1	1	1

[1/] Parts are not required for emergency generator sets.

Table I - Onboard repair parts (Continued)

Part designation	Parts required		Number of engines installed per ship					
	Type A	Type B	1	2	3	4	6	8
Thermostatic valve[1/]	No	Yes	1	1	1	2	2	3
Electrolysis protectors	No	Yes	25%	50%	75%	100%	150%	200%
Sea water pump impellers	No	No	1	1	1	2	2	3
Fresh water pump impellers	No	No	1	1	1	1	2	2
Hose connections	No	Yes	50%	50%	100%	100%	150%	200%
V belts	No	Yes	50%	50%	100%	100%	150%	200%

[1/] Parts are not required for emergency generator sets.

3.4.2 Special tools. - Special tools shall consist of non-standard gages, seating tools, reamers, pullers, templates and wrenches required for disassembly, repair and assembly of engine parts. One set of special tools is required for each engine room. Special tools are those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Government inspector).

3.4.3 Onboard and stock repair parts lists. - Onboard and stock repair parts lists and list of special tools shall be furnished in accordance with MIL-P-15137.

3.5 Drawings. - Drawings of production or existing parts, components or equipment applicable to a contract or order shall consist of manufacturer's commercial shop drawings.

3.5.1 Approval of drawings. - After award of a contract and within the time specified in the contract or order, the prime contractor shall submit two prints of installation drawings of the engine and driven equipment, detached components, accessories, and controls to the bureau or agency concerned for approval.

3.5.2 Installation drawings. - Installation drawings shall show the overall dimensions for the following:

(a) Overall dimensions for the complete assembled unit.
(b) Foundation bolting dimensions.
(c) Wet and dry weights, including detached accessories.
(d) Centers of gravity in at least 2 planes.
(e) Clearances for removal of parts such as cylinder heads, pistons, liners, cooler tube bundles, camshafts, pumps and blowers.
(f) Bill of material describing make, model and quantity of equipment and accessories being furnished.
(g) Capacity of blowers and pumps at rated engine speed and volume of exhaust gases at rated speed and load specifying pressure and temperatures for which data apply.
(h) Show BHP, BMEP and RPM.
(i) Location and size of pipe connections to engine and accessories.
(j) For all engines
    (1) Diagrammatic sketches of piping systems, indicating pipe sizes, type of fittings and relative

location of coolers, filters, valves, strainers, thermometers and gages. Contractor furnished piping shall be shown by solid lines and shipbuilder furnished piping by broken lines.

3.5.3 When specified (see 6.1), a reproducible drawing of the approved installation drawing shall be furnished.

3.5.4 Microfilm of drawings. - A set of engine drawings shall consist of microfilm on reels of all installation and assembly drawings together with detail drawings of parts for each component, except accessories exempted herein. Drawings of items on Qualified Products Lists and standard hardware such as bolts, nuts, washers, cotter keys and similar items that are fully described in bills of material, and drawings of pieces used in the fabrication of a welded part shall not be included in the microfilm. Microfilm shall be in accordance with MIL-M-9868.

3.5.4.1 A microfilm index of drawings, listing manufacturer's drawing numbers, name of drawing and microfilm frame number of each drawing, shall be submitted for approval prior to actual microfilming. Drawings shall be arranged as component groups headed by the assembly drawing. The index shall be preceded by a summary list of drawings showing installation drawings and component assembly drawings, and list the applicable index sheets. Detail microfilm drawings are not required for the following list of accessories.

(a) A cross-section drawing with Bill of Material is sufficient for the following items:
  (1) Regulating and overspeed governors.
  (2) Lube oil strainer.
  (3) Lube oil filter.
  (4) Thermostats or temperature regulators.
  (5) Air starting motors.
  (6) Air intake filter/silencer.
  (7) Pneumatic control devices.
  (8) Fuel oil filter.
  (9) Mufflers.
  (10) Coolers.

(b) An outline drawing will suffice to complete drawing requirements for the following accessories:
  (1) Tachometer.
  (2) Tachometer generators.

(3) Pressure gages.
(4) Thermometers.
(5) Pyrometers.
(6) Thermocouples.
(7) Flexible exhaust hose.
(8) Expansion tanks.
(9) Valves (relief, safety, throttling, regulating, reducing, and similar types).
(10) Mechanical controls.

3.6 Manuals. - A technical manual and a parts manual shall be furnished in accordance with Type I MIL-M-15071 for the equipment procured under the contract or order. Parts manuals may be bound with the technical manual or furnished separately. One copy of each manual shall be packed with the engine. If finished manuals are not available at time of shipment, preliminary manuals shall be packed with the engines, and replaced later when finished manuals are available. The manual shall contain all information required for a complete understanding of the construction and operation of the engine and associated equipment. It shall also contain information on maintenance and overhaul which shall be as complete as necessary for use by a well equipped machine shop to maintain and overhaul the engine and associated equipment without assistance by the manufacturer. The manuals shall have a comprehensive index referring to drawings, diagrams, and photographs as required. A listing of engine parts, and manufacturer's parts numbers, shall be provided. Each page shall have a page number and the cover shall show the NAVSHIPS number as assigned by the bureau or agency concerned. The engine installation piping sketches and coupling drawings shall, in addition, specify the part and number for the magnetic counterpart or replacement for the non-magnetic parts. Coded designations shall be used to designate whether they are magnetic or non-magnetic. (i.e., A column entitled "Engine Use Code" can be added to the parts list. Under this column the symbol "A" can be used for the non-magnetic part and the letter "B" for the magnetic counterpart as well as all other magnetic parts.) The Parts list shall also contain a column designating the basic material (i.e., Bronze, CRES, CRS, Neoprene, etc.).

3.6.1 Engine manuals shall include a table of normal clearances, diameters and thickness for new parts, and maximum allowable clearances and wear limit for wearing parts. These data shall be furnished for all wearing parts. Torque settings of important nuts shall also be listed.

3.6.2 In lieu of separate chapter on maintenance for the various component parts of an engine the chapter or sections of the manual covering detailed description of parts should also include maintenance instructions for the part. The chapter on maintenance should concern only the complete engine assembly or unit.

3.6.3 Two preliminary copies of the manual shall be submitted to the bureau or agency concerned for approval.

3.6.4 The quantity of manuals required and the delivery point(s) shall be as specified (see 6.1).

3.6.5 Technical manuals for a complete propulsion or generator unit including one or more engines, couplings, generator or reverse reduction gear, shall contain complete and comprehensive alignment instructions for the entire plant. The instructions shall cover original alignment procedure, with maximum limits for radial and axial deviation, and information for alignment checks after installation. A machinery layout sketch showing locations of measurements, and space for recording measurements shall be provided.

3.7 Workmanship. - Castings shall have a workmanlike finish and shall be free from shrinks, cold shuts, cracks, harmful porosity, and other defects which make the castings unsuitable for the intended purpose. Runners, risers, fins and other cast on pieces shall be removed. Sharp edges on projections shall be removed from stampings or forgings in the finished part. Machined surfaces shall have sharp edges broken or chamfered. Welds shall be free of weld splatter or slag. Forgings shall be free from seams, cracks, scale, fins, porosity, hard spots, or excessive inclusions, segregations or other defects.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification; where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Test data. - Test data for the first engine on any contract or order, shall be forwarded to the bureau or agency concerned via the Government inspector for approval. Test data shall be submitted on supplier's test forms or on large sheets with lines for folding to 8 by 10½ inches for filing. The dynamometer output of the engine shall be such as to insure that the identification plate output as specified in the contract or order can be obtained under standard conditions. The dynamometer output necessary to satisfy this requirement shall be determined using the following formula:

$$BHP_d = \frac{BHP_n}{\frac{P_s}{P_o}\sqrt{\frac{T_o}{T_s}}}$$

4.2.1 All temperature and pressure readings necessary for complete evaluation of the engine performance, including ambient room temperature, barometric pressure and relative humidity, shall be entered on the test sheets. Fuel consumption in pounds per hours shall be entered for all runs of sufficient duration for engine conditions to become stabilized. All additions of lubricating oil and oil changes shall be recorded.

4.2.2 Readings of instruments shall be recorded at intervals not exceeding 1 hour. When a phase of a test is of such short duration that operating temperature cannot be stabilized, no reading is required.

4.2.3 Fuel used during the tests shall have a maximum cetane number of 52. Fuel consumption shall be corrected for the difference in high heat value of the fuel actually used during the test and the standard 19,350 British thermal unit (B.T.U.) per pound.

4.2.4 The exhaust back pressure at the engine exhaust outlet for rated load and speed shall be 1 inch Hg.

4.2.5 The test data recorded shall be submitted in tabular form and in the form of curves as follows:

(a) Specific fuel consumption in pounds per BHP hour, fuel consumption in pounds per hour, exhaust gas temperature, injection pump rack position (if practical), and air box pressure versus BHP. Data shall include all speeds and loads specified in 4.3.2.4.

(b) Fuel consumption at no load in pounds per hour versus speed.
(c) With BHP as the ordinate and rpm as the abscissa, draw lines of constant BMEP, and superimpose curves of constant fuel consumption.
(d) To determine the control of the load limiter, (when applicable) on engine output, a curve of maximum BHP or BMEP versus rpm for the operating range of the engine shall be furnished.

4.2.6 Compression pressures for each cylinder at idling speed, and firing pressure at rated load and speed shall be obtained after endurance tests on all engines over 6 inch bore.

4.3 Tests. - Sea water systems for submarine installation shall withstand a hydrostatic pressure equal to the amount specified (see 6.1).

4.3.1 The method of assembly and the tightness of joints in the engine piping system, after being fully assembled on the engine, shall be tested under pressure equal to a test pressure 50 percent in excess of the working pressure if specified (see 6.1).

4.3.2 First production engine performance tests. - First production engine performance tests and post trail examination shall be conducted in accordance with 4.3.2.1 thru 4.3.2.8.1.

4.3.2.2 Endurance test. - Engines shall be run for 125 eight hour cycles as follows:

2 hours at rated load and speed.
1 hour at 85 percent load and rated speed.
10 minutes at minimum idling load and speed.
1 hour and 50 minutes at rated load and speed.
10 minutes at minimum idling load and speed.
30 minutes operation at 50% load at rated speed.
10 minutes at minimum idling load and speed.
10 minutes at 85 percent load and rated speed.
1 hour and 50 minutes at 110 percent rated load at rated speed.
10 minutes shutdown (minimum between each cycle).

Engines may be shutdown, as required, between each complete cycle or full cycles may be run on a continuous basis.

4.3.2.2.1 During the endurance test (see 4.3.2.2), the fuel consumption and exhaust gas temperatures for runs not less than ½ hour shall be recorded: fuel pump rack setting, if available, shall be recorded for all test loads.

4.3.2.3 Maneuvering test for direct reversing engines. The direction of rotation of the engine shall be reversed by power a total of 100 times. Full load shall be applied between each reversal. The time for reversal shall be determined to demonstrate compliance with 3.1.18.3. The total quantity of air used in the 100 reversals shall be recorded and the average quantity for each reversal calculated in cubic feet of free air at 14.7 psi and 68°F. The minimum air pressure and time at which a reversal can be accomplished shall be determined.

4.3.2.4 Fuel consumption. Fuel consumption tests of ½ hour duration with sufficient time intervals between each run for stabilization of operating conditions, shall be made on propulsion engines at 100, 90, 70, 50 and 30 percent rated speed for each load of 0, 40, 80, 100 and 110 percent BHP at rated speed. If the engine cannot be operated continuously at 30 percent rated speed, the lowest safe operating speed shall be substituted. For speeds below rated speed, 100 percent BHP shall be defined as maximum BHP which the engine can carry safely with a clear exhaust.

4.3.2.5 Cold starting tests. If specified (see 6.1) engines shall be subjected to a cold starting test. Prior to the test, the engine shall have been shutdown for at least 12 hours. Cold water at temperature not exceeding 35°F shall be circulated through the engine for at least 1 hour or until all parts of the engine are cooled to a reasonably uniform temperature. The engine shall fire and continue operating within 10 seconds after the starting mechanism is set in operation. Where air starting is used, the minimum quantity of air expressed in cubic feet of free air at 14.7 psi and 68°F for the start shall be determined.

4.3.2.5.2 Normal starting. Immediately following the cold start test, (see 4.3.2.5) nine consecutive starts shall be made under normal ambient conditions. The average time required to start the engine, and the minimum starting rpm shall be determined. The engine shall fire and continue operating within 5 seconds after the starting mechanism is engaged.

4.3.2.5.3 If air starting is used, the following data shall be obtained:

(a) The minimum quantity of air, expressed in cubic feet of free air at 14.7 psi and 68°F, necessary for each of 10 successive starts, including the cold start.
(b) The minimum air starting pressure at which the engine will start within the 5 second time limits.

4.3.2.5.4 When electric starting is used, the break-away and rolling starting motor current and voltage shall be recorded.

4.3.2.6 Regulating governor. - Tachographic records of engine speed changes shall be made to determine compliance with 3.1.18.1.

4.3.2.7 Overspeed governor. - During the overspeed governor test, the regulating governor shall be made inoperative. The engine speed shall be increased above rated speed until the overspeed governor acts to determine the rpm at which the overspeed governor is set.

4.3.2.8 Post trial examination. - After completion of all tests, the engine shall be disassembled and examined. For this purpose, all cylinders shall be opened, pistons pulled and the cylinder bores, pistons, piston rings, wrist pins, and crankpin bearings examined for defects and measured for wear after crankshaft deflection has been recorded. Gear train covers and all crankcase covers shall be removed for examination of internal parts. The engine shall be barred over during examination to determine extent of backlash in gear trains. The reverse-reduction gear, if furnished shall be examined and measured for wear. Mating surfaces of gears and all bearings shall be checked for distress such as pitting and galling. Excessive wear, broken or damaged parts, scored cylinders, burned valves or signs of severe stress or excessive wear will cause rejection of the unit. A complete report shall be submitted to the bureau or agency concerned.

4.3.2.8.1 Special tools furnished with the engines shall be tried out on the engine during the post trial examination, before examination can be considered complete.

4.3.2.9 During tests specified in 4.3.2, the engine cooling water shall be treated to prevent corrosion.

4.3.3 Duplicate engine routine tests. Production engines, duplicates of one which has been satisfactorily tested in conformance with 4.3.2.1 thru 4.3.2.9, shall be tested in accordance with the manufacturer's standard production procedure.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts. -

5.1.1 Engines, accessories and attached reduction gears.

5.1.1.1 Preservation and packaging. - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation and may conform to the supplier's commercial practice when such meets these requirements.

5.1.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier, at lowest rate, and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules and Regulations or other carrier regulations, as applicable to the mode of transportation and may conform to the supplier's commercial practice when such meets these requirements.

5.1.1.3 Marking.- Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the supplier's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, contract or order number, supplier's name and destination.

5.1.2 Repair parts and special tools. - Mechanical and electrical repair parts shall be preserved, packaged and marked in accordance with MIL-R-196, MIL-P-16789, MIL-P-16298 or MIL-E-17555, as applicable. Tools shall be preserved and

packaged in accordance with MIL-P-17286 or MIL-H-15424, as applicable. Unless otherwise specified (see 6.1) repair parts and special tools shall be packed in accordance with 5.1.1.2.

5.2 Domestic shipment and storage or overseas shipment. - The requirements, and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.1).

5.2.1 The following provides various levels for protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made.

5.2.1.1 Preservation and packaging.

5.2.1.1.1 Level A.

5.2.1.1.1.1 Engines, accessories and attached reduction gears. - Engines, accessories and attached reduction gears shall be preserved and packaged in accordance with type IV, method I or II of MIL-E-10062 to the extent specified.

5.2.1.1.1.1.1 Lubricating oil, fresh and sea water systems. - Preservative type P-10, grade 2, in accordance with MIL-L-21260, shall be used throughout the engine and gear, fresh water, sea water and lubricating oil systems in lieu of the P-2, P-3 and P-9 preservatives specified in MIL-E-10062. In addition the fresh water system shall be drained and completely dried with warm air prior to preservation. If it is impractical to perform a drying out procedure, the cooling system shall be flushed with a soluble oil conforming to MIL-I-19841, which will emulsify the water and remove it on draining. The system shall then be flushed with the specified preservative.

5.2.1.1.1.1.2 Fuel oil system. - Preservative type P-10, grade 2 shall be used throughout the fuel system. A substitute, satisfactory to the bureau or agency concerned, may be used for those fuel systems where passages and orifices are so small as to prevent pumping of type P-10 throughout the system. Injectors shall not be removed from engines for the purpose of preservation.

5.2.1.1.1.1.3 Valve mechanism. - Access covers shall be removed and all surfaces within the valve compartment, including rocker mechanisms, valve stems, springs, guides, push rods

and the inside face of the cover plate shall be coated with P-10 preservative.

5.2.1.1.1.1.4 Transmission and transfer case. - Transmission and transfer case and any other gear trains not lubricated by the main engine lubricating system shall be drained of lubricant and all surfaces within the housing coated with P-10.

5.2.1.1.1.1.5 Generators. - Battery charging generators shall be preserved and packaged level A in conformance with MIL-P-16298. When the size and mounting of the generator attached to the engine does not permit enclosure of the generator within a water-vapor-proof barrier as required in a method II package the alternate method of packaging may be used.

5.2.1.1.1.1.6 Sealing. - All inlet and outlet openings to the engine and accessories shall be covered with barrier material conforming to grade A of MIL-B-121, and a blank flange of mild steel, tempered hard board or fully waterproof plywood. On openings up to 2½ inch diameter, plastic plugs or caps may be used in lieu of barrier material and blank flanges.

5.2.1.1.1.2 Detached instruments and accessories. - Detached instruments and accessories shall be preserved and packaged level A in accordance with MIL-R-196, MIL-E-17555 or applicable instrument or accessory specification.

5.2.1.2 Packing of engines, gears and attached accessories.

5.2.1.2.1 Level A. - Each engine with gear and attached accessories shall be individually packed in sheathed crates conforming to MIL-C-104. Engine units shall be anchored, blocked and braced within the shipping container to resist damage and shock during shipment and storage. The anchoring, blocking and bracing of crate contents and closure of crates shall be in conformance with the appendix of MIL-C-104.

5.2.1.2.2 Detached instruments and accessories. - Detached instruments and accessories shall not be packed in the same box with repair parts or special tools. Detached instruments and accessories shall be packed separately and secured in the engine shipping crate. The containers shall conform to any of the following at the option of the supplier:

PPP-B-576. . . . . Class 1
PPP-B-585. . . . . Class 1 or 2
PPP-B-591. . . . . Domestic
PPP-B-601. . . . . Domestic
PPP-B-621. . . . . Class 1
PPP-B-636. . . . . Domestic
PPP-B-640. . . . . Class 1

Box closure shall be in accordance with the applicable box specification or appendix thereto. The gross weight of containers shall not exceed the weight limitations of the applicable box specifications.

5.2.1.2.3 Marking. -

5.2.1.2.3.1 Special marking. - All engines preserved level A shall be tagged as follows:

"The fluid systems of this engine have been preserved with type P-10 preservative. No special de-preservation procedures are required with the exception of fresh water system. De-preservation of the fresh water system shall be in accordance with Section II, paragraph 41-438, Chapter 41 of the Bureau of Ships Technical Manual."

5.2.1.2.3.2 Additional marking. - In addition to any special marking requirements, interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

5.2.2 Repair parts (other than submarine). - Repair parts (other than submarine) shall be preserved and packaged level A; packed level A, B or C and marked in accordance with 5.1.2.

5.2.2.1 Repair parts (submarine). - Repair parts (submarine) shall be preserved and packaged level A, packed level A, B or C and marked in accordance with 5.1.2. Level A preservation and packaging methods shall be modified in accordance with MIL-STD-758 for items that can be stored in bins or drawers.

5.2.3 Manuals (bulk). - Manuals (bulk) for shipboard electrical and mechanical equipment shall be prepared for shipment in accordance with MIL-M-15071.)

6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Type required (see 1.2).
(c) Engine rating and speed (see 3.1.1).
(d) Standard operating conditions (see 3.1.1.1).
(e) Dimensions and wet weight (see 3.1.2).
(f) When shock resistance is required (see 3.1.3 and 10.2 and 30.2 of Appendix).
(g) When resiliently mounted equipment is required (see 3.1.4).
(h) Accessory equipment required (see 3.1.9).
(i) When lubricating oil scavenging pump is required (see 3.1.15.2.1).
(j) When HI-shock resistance is specified for coolers (see 3.1.15.2.2 and 3.1.15.3.2).
(k) Starting system (see 3.1.16).
    (1) Type of starting system.
    (2) Voltage or operating pressures.
    (3) Number of reducing valves required.
    (4) Whether an automatic shutdown valve is required.
(l) Whether extreme cold starting is required (see 3.1.16. 1).
(m) Exhaust system (see 3.1.17)
    (1) Whether muffler is required.
    (2) Type of muffler required.
(n) Type of governor required (see 3.1.18).
(o) Overspeed governor (see 3.1.18.4).
(p) Whether air intake filter is required (see 3.1.19).
(q) Whether an emergency shut-down device is required (see 3.1.21.1).
(r) Reverse reduction gear (see 3.1.22).
    (1) Whether reduction gear is required.
    (2) Reduction gear ratio.
(s) Additional accessories required for type A engines (see 3.2.1).
(t) Inclination (see 3.2.4 and 3.2.4.1).
    (1) Inclination angle requirements.
    (2) Installation angle.
(u) Additional instrument requirements (see 3.2.7).
(v) Type of tachometer required (see 3.2.7.4).

(w) Type of pyrometer required (see 3.2.7.5).
(x) Control system (see 3.2.8).
(y) Type of auxiliary hand operation required (see 3.2.8.1).
(z) If air intake silencer and cleaner is required (see 3.2.9).
(aa) Additional operating requirements for type B (see 3.3.1).
(bb) Inclination angle requirements (see 3.3.2).
(cc) Additional accessory requirements for type B (see 3.3.3).
(dd) Type of propeller shaft coupling (see 3.3.5).
(ee) Mounting of heat exchangers for type B engines (see 3.3.6.2.1).
(ff) Belt speed required for auxiliary drive (see 3.3.7).
(gg) Reverse-reduction gear required (see 3.3.9).
(hh) Instrument and panels required for type B (see 3.3.10).
(ii) Electrical requirements for type B engines (see 3.3.11).
(jj) Starting motor and contactor required (see 3.3.11.1).
(kk) Battery charging generator and voltage regulator (see 3.3.11.2).
(ll) Controls required (see 3.3.12).
(mm) Repair parts (see 3.4.1).
(nn) When reproducible drawing is required (see 3.5.3).
o) Quantity of manuals (see 3.6.4).
(pp) Exhaust back pressure setting required during tests (see 4.2.4).
(qq) Hydrostatic pressure for submarine installation (see 4.3).
( ) Test pressure (see 4.3.1).
(ss) When engines should be tested under cold and extreme cold conditions (see 4.3.2.5 and 4.3.2.5.1).
(tt) Type B duplicate engine tests (see 4.3.3).
(uu) Tests required for submarines (see 4.3.4).
(vv) Packing required for repair parts and special tools (see 5.1.2).
(ww) Preservation, packaging, packing and marking required if other than specified in 5.1 (see 5.2).
(xx) Data required with bids (see 6.1.1).

6.1.1 Bid data. - When specified (see 6.1), complete engine and accessory data should be submitted in accordance with figure 2 for evaluation of bids. Shipbuilders, procuring engines as part of a contract for a ship, should obtain approval of the make, model, speed and power rating for each application, from the bureau or agency concerned prior to placing an order with the engine manufacturer.

CASE 2

REPLACEMENT OF SIDING ON FAMILY HOUSING

CASE 2

REPLACEMENT OF SIDING ON FAMILY HOUSING

This case is a real procurement of goods and services and covers the purchase and installation of new siding for on-base housing at Fairchild AFB, Washington (IFB No. F45613-69-B-0138)

The interest rate specified in the Bid Evaluation statement and all subsequent calculations were changed from the original documents to reflect the requirements of DoD Instruction 7041.3, 26 February 1969.

The unique features of this Case are the illustration of the applicability of LCC in determining the value of different warranty periods and use of a bonded warranty to insure the specified performance.

BACKGROUND

The Air Force has embarked on a repair and rehabilitation program for 25 to 35 year old on-base housing (often referred to as Wherry Housing). The original siding on these units was asbestos shingle. With time, this brittle material became dirty, discolored, chipped, and broken.

With its experience and engineering analysis on a variety of types of building siding, the Air Force has decided to specify four types as being suitable for family housing - prefinished hardboard, vinyl-aluminum overlaid plywood, extruded polyvinyl chloride, and polyvinyl fluoride overlaid plywood. In order to allow for the introduction of newer and better materials, a provision is inserted in the IFB allowing for such introduction during a specified time period prior to bid acceptance.

The contract being awarded includes a number of miscellaneous repairs such as the removal and replacement of moldings, door and window frames and trim, metal louvers, etc. The major portion of the contract covers the removal and replacement of siding and it is this portion only which will be discussed in this Case.

Siding will be replaced on 168 buildings at Fairchild AFB, Washington. The estimated quantity of siding is 226,700 square feet of which 63,997 square feet will be in dark colors and 162,703 square feet in white or light colors.

TABLE 2A

LIFE CYCLE COST ELEMENTS - CASE 2

Initial

Purchase Price - INCLUDED

Delivery (Transportation) - N.I. Bidders to furnish finished product in place. Included in purchase price.

Testing - N.I.

Installation and Start-up - INCLUDED

Inventory Management - N.I. Not applicable

Training - N.I. Not needed

Operating

Item Life - INCLUDED

Operating Labor - N.I. Not needed

Materials - N.I. Not needed

Utilities - N.I. Not needed

Training - N.I. Not needed

Preventive Maint. - INCLUDED

Corrective Maint. - INCLUDED

Discussed together

Inventory Management - N.I. None expected

Requirements - N.I. None expected

Final

Dismantling - N.I. Costs to be included in next installation contract.

Residual Value - N.I. None expected.

N.I. = Not Included

LIFE CYCLE COST ELEMENTS

Table 2A (page 3) shows the LCC elements considered in this Case.

SYSTEM AND ITEM LIFE — After completion of the rehabilitation program, the housing units are estimated to have a remaining life of 25 years. The item (siding) life is not specified since the bid calls for a warranty from the manufacturer on his product. The warranted item life is thus the major variable in the bid evaluation.

INSTALLATION — In this Case, installation cost includes the cost of the siding material and is therefore included in the base price.

MAINTENANCE — The projected maintenance cost is the life cycle cost element that is used as an additive to determine the true total life costs of the various sidings. The Air Force has estimated that a normal paint coating will last approximately five years. Therefore, when the purchased siding fails with respect to color fading or surface costing, a 5-year painting cycle is begun which will continue for the remaining life of the system (the building). If there is a failure in the substrate, the siding must be replaced.

In projecting future maintenance costs, a 3% per year inflation factor is used and future costs are discounted to a present value at a rate of 13% per year*. The determination of the maintenance element of the life cycle cost is detailed in the IFB as follows:

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*In this Case, the inflation and discounting calculations were adjusted to conform to DoD Instruction 7041.3. The 13% rate used (which includes a 3% inflation factor) is equivalent to the "current dollar" 10% rate specified in the Instruction.

THIS EVALUATION AND AWARD STATEMENT SHALL APPLY TO EACH OF THE THREE BIDDING SCHEDULES.

EVALUATION AND AWARD STATEMENT

AWARD The award of this contract will be determined by evaluating bids in the following manner:

Bids submitted on Item 1 of Bidding Schedule I, II and III will be evaluated in accordance with the formula established below to determine the most economical type of siding of each bidder. The bid cost of all other items on the applicable schedule will then be added to the total present day value cost of the most economical type of siding to determine the grand total of each bid, and a single award will be made to the responsive bidder who submitted the lowest evaluated grand total bid.

EVALUATION Evaluation of Bid Item I for types of siding will be accomplished as follows:

From the manufacturer's guarantee, anticipated future maintenance/repair costs including replacement of siding will be computed for a 25 year period utilizing a five year painting cycle starting at the end of the product fading or coating guarantee, whichever is of the shortest duration and complete material replacement at the end of the substrate guarantee. Maintenance painting costs will be computed utilizing a cost of $0.06/SF. Siding replacement will be computed utilizing the unit price bids. Both of the above prices will be increased by 3% per year. Each maintenance item will be reduced to its present day value by multiplying the future estimated cost by the product of this formula:

$$\left(\frac{1}{1+i}\right)^n$$

Where i = 13% interest rate
n = number of years from now until the applicable maintenance/repair is required

EXAMPLE: Let n = 15 years

Computed cost of painting at the end of the 15th year is:

$$\$0.06/SF \times (1 + 0.03)^{15\ yrs} = \$0.06\ (1.558)$$

$$= \$0.093/SF$$

$$\text{Present value} = \$0.093/SF\left(\frac{1}{1 + .13}\right)^{15}$$

$$= \$0.093\ (0.8850)^{15}$$

$$= \$0.093\ (0.160)$$

$$= \$0.015$$

THE AGGREGATE OF BASIC SIDING BID PLUS PRESENT DAY VALUE OF FUTURE ANTICIPATED MAINTENANCE WILL DETERMINE THE MOST ECONOMICAL SIDING OF EACH BIDDER.

* * * *

The equation used in the Evaluation section above is the usual determination of the present value of a cash flow occurring at a future point in time. This equation is appropriate in this case since future paintings presumably could be contracted for and paid in a lump sum at the completion of work. The resulting present value factors differ from those used in DoD Instruction 7041.3, 26 February 1969, since the Instruction considered cash flows occurring uniformly over a period of time.

BID EVALUATION

Three bidders submitted a total of six bids on the four types of siding - one bid for prefinished polyvinyl fluoride on hardboard, two for extruded polyvinyl chloride, and three for pre-finished polyvinyl fluoride on plywood. No bids were received for vinyl-aluminum overlaid plywood.

Although bonds were not received for all bids and these non-bonded bids were declared non-responsive, it will be assumed that a bond was provided for all bids and all bids have been included in the evaluation.

The bid evaluation is shown on Table 2B.

The successful bid is Bid A.

TABLE 2B

BID EVALUATION: CASE 2

Bid and Evaluation Element	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
Material	PVF/Hdbd.	PVF/Plywd.	PVC	PVC	PVF/Plywd.	PVF/Plywd.
Substrate warranty	25 yrs.	25 yrs.	25 yrs.	25 yrs.	25 yrs.	25 yrs.
Color warranty: dark	10 yrs.	10 yrs.	25 yrs.	25 yrs.	10 yrs.	10 yrs.
light	15 yrs.	15 yrs.	25 yrs.	25 yrs.	15 yrs.	15 yrs.
Surface warranty	25 yrs.	25 yrs.	25 yrs.	25 yrs.	25 yrs.	25 yrs.
Installed cost	$179,093.00	$194,962.00	$228,967.00	$247,103.00	$235,768.00	$256,171.00
Present Value of Painting						
11th yr.-dark colors	$ 1,386.18	$ 1,386.18			$ 1,386.18	$ 1,386.18
16th yr.-dark colors	870.36	870.36			870.36	870.36
16th yr.-light colors	2,212.76	2,212.76			2,212.76	2,212.76
21st yr.-dark colors	549.09	549.09			549.09	549.09
21st yr.-light colors	1,395.99	1,395.99			1,395.99	1,395.99
Total 25-year est. maint cost (discounted)	$ 6,414.38	$ 6,414.38	-	-	$ 6,414.38	$ 6,414.38
Total Life Cycle Cost	$185,507.38	$201,376.38	$228,967.00	$247,103.00	$242,182.38	$262,585.38

DISCUSSION

Although the application of LCC in this Case had no apparent effect in the outcome, the important aspect is that the contracting officer could not have known that Bidder A was low bidder in life cycle terms. Given different warranty periods, the results would have differed. Conceivably, Bidder C may have had the lowest overall costs. Therefore, by this method, the contracting officer was assured of obtaining the best material in terms of total life cycle costs.

This Case is also of interest because of its unique method of insuring the reliability of a bidder's estimate of product quality. The bidder must submit a bonded warranty on his claimed performance. Total life cycle cost may then be calculated for the expected system life. The penalty is a relatively simple one--the bidder must bear the cost of replacement if failure occurs prior to the end of the warranty period. The wording of a typical warranty is:

KNOW ALL MEN BY THESE PRESENTS: That, (Name and Address of Manufacturer) as Principal, and (Name and address of the Bonding Co.), a corporation organized under the laws of the State of _____, as Surety, are held and firmly bound unto the Department of the Air Force, care of the Contracting Officer, _____ Air Force Base, _____ _____ in the sum of _____and 00/100 ($ .00), lawful money of the United States of America, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

SEALED with our seals and dated this _____ day of _____, 19__.

WHEREAS, the Principal is supplying (type of siding material) in connection with contract No. _____, and

WHEREAS, the Department of the Air Force is requiring a manufacturer's guarantee as stated herein:

The Period of the manufacturer's written guarantee will begin at the end of the day that the total project is accepted by the Government. The manufacturer will furnish in writing at the time of bid the following:

9.4.1 Color Fading: A guarantee that the siding will not show unsightly discoloration, mottling, or fading for the period of ____ years.

9.4.2 Surface Coating: A guarantee that the surface coating will not chip, dent, peel, blister, or flake for the period of ____ years.

9.4.3 Substrate Material: A guarantee that the substrate material of the siding will not deteriorate so as to render the siding unserviceable and the substrate material will remain free of bulging or other distortions for the period of ____ years.

9.4.3.1 If, in the opinion of the Contracting Officer, a defect is discovered which is contrary to a guarantee, the manufacturer will provide material and labor as often as necessary throughout period of the original guarantee at no cost to the Government, to correct such deficiency. At the option of the Government, the manufacturer will pay the Government in cash for the labor required to correct deficiencies covered under the above guarantees and will furnish without charge to the Government the necessary paint, siding and other materials for repair or replacement.

9.4.3.2 The manufacturer will not be liable under the above guarantees for any defects or damages resulting from unforeseeable causes beyond the control and without the fault or negligence of the manufacturer such as misuse or neglect by the Government, acts of God, acts of the public enemy, fires, floods, and hurricanes.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that the Principal shall well and truly make good such defects in material or workmanship which may arise within the period stated herein. Then this obligation shall be null and void, otherwise it shall remain in full force and effect.

Seal of Principal

By: _____

Seal of Surety

By: _____

9.5 If the Certificate required in 9.4 above is not furnished at time of bid opening, the entire bid will be rejected.

Note that this warranty is between the siding manufacturer and the government. To insure that the manufacturer's warranty is applicable after installation by the contractor, a clause is included requiring the manufacturer to approve the installation, as follows:

9.2 Before the final acceptance of the project by the Government, the manufacturer shall furnish in writing to the Contracting Officer a statement that siding has been installed in accordance with his published procedures and methods of installation.

* * * *

To make this type of procurement, the following data must be specified and included in the IFB and contract:

- Total system life
- Minimum performance requirements
- Limiting design requirements (dimensions, rate of inputs or output, etc.)
- Cost of repair and replacement.

This method may be applicable to other procurements provided certain criteria are met.

The apparent limitation is that the contractor must be assured of the operating conditions. In this case housing siding will be installed in a permanent location subject to historically documented weather conditions. If this criterion of environmental knowledge were satisfied, a warranted procurement appears to be feasible. If the item were a stationary piece of equipment which required preventive maintenance, it could be performed by the contractor and included in the bid price.

Thus typical equipments which could be purchased on this basis are:

- stationary boilers and generators
- room air conditioners
- standby utility equipment
- office machinery
- ADP equipment*

It is doubtful that a warranted procurement could be made on items subject to changing environments, military tactical operations, or misuse in operation or maintenance.

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*Case 7 involves contractor-performed maintenance on EDP equipment and a determination of the probable amount of corrective maintenance.

CASE 3

SOLID STATE, 15 MEGAHERTZ OSCILLOSCOPES

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CASE 3

SOLID STATE, 15 MEGAHERTZ OSCILLOSCOPES

This is a real procurement made by the Air Force Logistics Command (AFLC). The bid[1] data submitted by "Contractors" are fictitious. However, the contract wording and formats are factual with minor changes in equation formats for clarity. A Present Value Calculation Format (end of Table 3C) has been added to provide the analysis required by DoD Instruction 7041.3, 26 February 1969. The RFP was issued prior to that date.

The equipment was requested under RFP F41608-69-R-H306.

The Case illustrates a rather complete LCC evaluation format suitable for inclusion in an IFB or RFP. Special attention is paid to the development of maintenance costs. There is also a portrayal and discussion of the sharing of cost risk in the structure of penalty provisions.

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[1] In conformance with USAF practice in the actual procurement, the words "bid" and "bidders" are used to mean proposals and those who submit them.

EQUIPMENT DESCRIPTION AND BACKGROUND

The equipment being procured is described in the RFP as quoted below together with additional background information. The specification and testing procedures are detailed in Appendix A.

1. The Department of the Air Force is contemplating the procurement of the supplies specified below by method of competitive negotiation on a potential Multi-Year Contract basis. Offers will be evaluated in two steps using Life Cycle Costing Award procedures. The resultant contract will also contain an adjustment feature which will provide for a reduction in the contract price in the event demonstrated performance does not meet the performance characteristics promised by the contractor and used as a basis for proposal evaluation and award.

a. Supplies and Services to be Furnished:

ITEM 1 - 6625-NC406173 OSCILLOSCOPES, Solid State 15 Megahertz in accordance with Purchase Description PD-SANE-6625-115 dated 15 Aug 1968 (Attachment 1) and in the quantities set forth below:

One Year Requirement	Quantity
1AA	253 each
Multi-Year Requirement	
1AB First Year Program	253 each
1AC Second Year Program	300 each
1AD Third Year Program	1,446 each

In addition to special information contained herein the contract shall be evaluated in accordance with the following attachments.

Basis for Evaluation of Technical Proposals (Attachment 2)
Maintenance Concept (Attachment 3)
Method of Bid Evaluation (Attachment 4)
Price Adjustment Provision with Graphic example (Attachment 5)

ITEM 2 - SPARE PARTS for ITEM 1 above to be selected and furnished in accordance with the provisions of "Spare Parts Provisioning Documents for USAF Aerospace and Associated

Equipment Contracts," AFPI Forms 71-683 or 71-684, dated June 1967, incorporated herein by reference.

ITEM 3 - Data for Item 1 as specified in DD Form 1423 attached as Exhibit "A" hereof. The Contractor shall deliver all data specified on the attached DD Form 1423.

The offeror shall set forth below a firm fixed price for each of the data items called for by the DD Form 1423. This firm fixed price will be considered in evaluation of offers. Offeror shall not submit proposals with the words "No Charge for Data" or "Data Price included in the price of the end item" except for data customarily furnished to commercial customers on this basis. The offeror is also requested to enter a total price in the space provided. Offerors who fail to complete blocks 25 and 26 of DD Form 1423 in accordance with instructions thereon as part of his original submission and refuses to complete them on request, may be considered non-responsive.

Data Item	Firm Fixed Price	Prior Contract
A001	_____	_____
A002	_____	_____
A003	_____	_____
A004	_____	_____

Total of above Data Items $_____

ITEM 4 - The Contractor shall furnish data Items B001, B002, B003, B004, B005, B006, B007, B008, B009, B010, B011, B012, B013, B014, B015, B016, B017, B018, B019, B020, B021, B022 and B023 specified on DD Form 1423 attached as Exhibit "B" for use by the Government in identifying, selecting and approving spare parts to be procured.

4AA Data for Item 2 (AFPI 71-683) excluding Exhibit Line Item B007

4AB Data for Item 2 (AFPI 71-684) excluding Exhibit Line Item B013

2. Delivery of the oscilloscopes is desired as follows:

First Article Test Procedures - 30 days prior to delivery of the First Articles.

First Articles - 5 each 60 days after date of receipt of contract.

Delivery of Production equipment - 60 days after receipt of First Article Approval by Government.

60 DAYS	90 DAYS	120 DAYS
53 each	100 each	100 each

Dates Desired by Government:

June 69, July 69 and August 69.

TABLE 3A

LIFE CYCLE COST ELEMENTS - CASE 3

Initial

Purchase Price - INCLUDED

Delivery (Transportation) - N.I. All items priced on delivered basis

Testing - INCLUDED

Installation and Start-up - INCLUDED as Technical Data Management Cost

Inventory Management - INCLUDED

Training - N.I.

Operating

Item Life - INCLUDED

Operating Labor - N.I. Not applicable

Materials - N.I. Not applicable

Utilities - N.I.

Training - N.I.

Preventive Maint. - INCLUDED

Corrective Maint. - INCLUDED

Inventory Needs - INCLUDED

Final

Dismantling - N.I. Not applicable

Residual Value - N.I.

N.I. = Not Included

LIFE CYCLE COST ELEMENTS

Seven life cycle cost elements, in addition to purchase price, are considered in this Case as shown on Table 3A (page 5). All elements have been combined in a precise statement of bid evaluation and award. The pertinent portions of the RFP are quoted below.

Philosophy of Life Cycle Costing

> In accordance with the Armed Services Procurement Act of 1947 it is the policy of the DoD to procure supplies and services from responsible sources at fair and reasonable prices calculated to result in the lowest ultimate overall cost to the government. In furtherance of this policy award of this contract will be made to the responsive-responsible bidder on the basis of lowest total cost of ownership by the government computed in accordance with the award evaluation criteria contained herein. Cost of ownership is defined to include the compilation of acquisition costs, initial logistics costs, and those recurring costs associated with the management, operation and maintenance of the item herein solicited for the projected life cycle period set forth herein.

Method of Bid Evaluation

1. Subsequent to response to the second step of this two-step procurement, bid evaluation shall be accomplished by determining the summation of Life Cycle Costs for the hardware proposed by each offeror. Award shall be made to the offeror whose hardware will provide minimum Life Cycle Cost to the Government, and whose hardware is otherwise responsive to the requirements of the basic solicitation and documents made a part thereof by attachment or reference. In the above context, Life Cycle Cost (LCC) equals Acquisition Costs (A) + Initial Logistics Cost (I) + Recurring Costs (R); i.e., LCC = A + I + R. The LCC bid evaluation equation will reduce the many elements of price and data required by the solicitation into the common measure of dollars. All appropriate pre and post award LCC computations shall be computed to the fourth significant decimal. For the purposes of LCC, three cost element categories have been established:

a. Acquisition (A) Costs are the agreed to unit prices for the delivery of the line items of hardware, data and services being procured.

b. Initial Logistics (I) Costs consist of the one-time logistics costs which are identifiable and will accrue to the item being bid upon. For example, these include the costs of item introduction and 1st year management, tech data reproduction, distribution and 1st year management.

c. Recurring (R) Costs are those costs accrued by the Government incident to operation, maintenance and management of the items being procured. This includes the costs of performing corrective maintenance, costs of performing file maintenance on technical data introduced, recurring costs associated with new parts or assemblies earlier introduced, etc.

2. Costs Associated with Acquisition (A):

a. Unit price to be provided by bidder.

b. Number of units to be procured as specified by the Government.

c. Initial technical data costs.

3. Costs Associated with Initial Logistics (I):

a. Technical Data management/Item = ∠(Number of pages of Technical Data) (Number of copies to be distributed) (Cost per page for initial reproduction and distribution) + (Cost per page for file maintenance 1st year) (Number of pages of Technical Data)∠ ÷ (Number of items being procured).

(1) Number of pages of Technical Data to be furnished by bidder.

(2) Number of copies for distribution as specified by the Government.

(3) Air Force estimated cost standard for initial reproduction and distribution of Technical Data is $4.00 per 1,000 pages or $.004 per page.

(4) Air Force estimated cost standard for 1st year file maintenance per page is $14.00.

b. Item Management Costs: These costs represent "over and above costs" because the Air Force must stock, store, and issue new operational items to support the new end item being procured.

(1) One-time item entry costs (per new item) = $171.01. The formula is $171.01 times the total number of "P" coded items identified. "P" coded refers to items which are new to the Air Force stock control system. They consist of those items which must be stocked, stored and issued by the Air Force in support of the item subject to repair that is being procured.

(2) A list in five copies of all items, bulk and otherwise, to be used in each end item. The listing will include vendor's (or manufacturer's) part number, item name (basic noun with significant adjectives), Federal manufacturer's five digit code, and Federal Stock Number (if known). Indicate on the foregoing listing the recommended maintenance spare parts, by line item, excluding bulk items, that the Government should stock for repair or overhaul of the end item.

(3) Further, each offeror shall be advised as follows--incident to the post award recomputation of LCC for purposes of determining the final price to be paid the contractor, the recomputation of item management costs shall be predicted upon the actual quantity of "P" coded items selected and provisioned under the terms of this contract.

c. Total Costs Associated with Government Acceptance/Reliability Testing = (Bid MTBF θ_0 - 2250 hours) ($2.9866).

4. Costs Associated with Recurring Logistics (R):

a. Technical Data Management/Item = $\Big[$(Cost per page of Technical Data for file maintenance 2nd and subsequent years of PIUP) $\left(\frac{\text{PIUP}}{12} - 1\right)$ (Number of pages of Technical Data)$\Big]$ (Number of Items being procured).[1] Air Force estimated cost standard for 2nd and each remaining year of PIUP for file maintenance per page is $6.00.

b. Item Management Costs: These costs represent recurring costs because the Air Force must maintain operational

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[1]PIUP is the projected inventory usage period in months.

items (spares) to support the end item being procured. Recurring Annual Materiel Management Cost (per new item) = $375.68. The formula is $375.68 times $(\frac{PIUP}{12} - 1)$ times the total number of "P" coded items identified.

c. Maintenance Costs will be calculated in the following manner:

Equation #1

Maintenance Cost/Item = [Expected Number of Failures during Projected Inventory Usage Period] [(Labor Cost/Failure + Material Cost/Failure + Transportation Cost/Failure)] + [Preventive Maintenance Cost/Item].

Equation #2

Expected usage (in hours) of each item being procured = [(Projected Inventory Usage Period in Months) (Hours of Operation/Month/Installed Item)] [quantity installed] ÷ [The sum of the present number of items in the inventory + the quantity of this new procurement].

Equation #3

Expected Number of Failures in Projected Inventory Usage Period/Item Being Procured = Expected Usage (in Hours) of Each Item Being Procured Divided by Mean Time Between Failures (MTBF).

Equation #4

$$MTBF = \left(\frac{\text{Bid Mean Time Between Failure}}{\text{Discrimination Ratio}}\right)$$

Discrimination Ratio "As defined in MIL STD 781."

"Mean Time Between Failure" (MTBF) is defined as that operating time interval between failures which the bidder states his item will provide divided by a specified discrimination ratio cited in the designated test plan contained in the solicitation.

Equation #5

Repair Labor Cost/Failure = ⌈Base Labor Standard(s) to detect, isolate, remove, replace⌋ ⌈Base Labor Rate⌋ + ⌈Base Labor Standard(s) (to repair)⌋ ⌈Base Labor Rate⌋ ⌈RTS fraction⌋ + ⌈Depot Labor Standard to Repair⌋ ⌈Depot Labor Rate⌋ ⌈NRTS fraction⌋.[1]

Equation #6

Repair Material Cost/Failure = ⌈Base Material Cost Standard⌋ ⌈RTS fraction⌋ + ⌈Depot Material Cost Standard⌋ ⌈NRTS fraction⌋.

Equation #7

Transportation Cost/Failure = ⌈2⌋* ⌈Weight⌋ ⌈(Standard Packing Labor Rate) + (Standard Packing Material Rate) + (Average Shipping Rate x Ratio** of Packaged Weight to Unpackaged Weight)⌋.⌈NRTS fraction⌋.

Equation #8

Preventive Maintenance Costs/Unit = ⌈Expected usage in hours of each item being procured/Operating hours (of each installed item) per month⌋ ⌈Preventive maintenance manhours per month⌋ ⌈Base labor rate⌋.

Equation #9

Preventive Maintenance Manhours/month = ⌈Manhours to accomplish calibration⌋ ⌈Number of times calibration must be performed per month⌋.

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[1] RTS means "repaired this station." NRTS means "not repaired this station."

*⌈2⌋ This element provides for shipment to and from the Depot.

** Ratio of weight of packaged item to its unpackaged weight - ZI = 1.285.

** Ratio of weight of a packaged item to its unpackaged weight - Overseas = 1.436.

Maintenance Equation Summary

Equation #1 = Equation #3 [(Equation #5) + (Equation #6) + (Equation #7)] + [Equation #8].

where: Equations #2 and #4 are used in the calculation of Equation #3 and Equation #9 is used in the calculation of Equation #8.

(1) The quantitative source evaluation format for Equations #1 through #9 is provided as Formats 5-8. These formats state the source for each equation element and also indicate whether the Government or the offeror is to provide the data for inclusion in the equation. The formats further show whether or not an element of data is subject to the offeror's option to provide. Also, the formats show which elements of data are required to be entered by the Government prior to issue of the solicitation.

(2) Reference the quantitative source evaluation format attached to this solicitation. The Government has entered specific data in the referenced attachment, and the bidders are required to enter certain specific data relative to their proposed hardware. In this particular solicitation, the bidders are required to enter for their proposed hardware the data required for entry in Blocks A.1 and F.1 of the attached quantitative source evaluation format. An example has been prepared on a copy of a quantitative source evaluation format to demonstrate the impact on LCC caused by variations in the data to be submitted by the bidders.

QUANTITATIVE EVALUATION FORMAT

			A	B	C	D
A.	MEAN TIME BETWEEN FAILURE (MTBF)					
	1. Time between failure cited by bidder in response to the solicitation.	_____		X		
	2. Discrimination ratio cited in solicitation (source is Test Plan II Mil. Std. 781).	1.5	X			X
	3. Computation of Equation 4.	_____	X			
B.	EXPECTED NUMBER OF FAILURES IN PROJECTED INVENTORY USAGE PERIOD PER ITEM BEING PROCURED					
	1. Expected usage (inhours) of each item being procured. (Obtain from line C.6.)	_____	X			
	2. MTBF (Mean Time Between Failures). Obtain from Line A.3.	_____	X			
	3. Computation of Equation 3.	_____	X			
C.	EXPECTED USAGE (INHOURS) OF EACH ITEM BEING PROCURED					
	1. Projected inventory usage period in months (IM or SSM will determine by review of program documents).	126 Mos.	X			X
	2. Hours of operation per month (IM or SSM will determine by review of program documents).	110 hours	X			X
	3. Total Quantity of in-use items.	1566	X			X
	4. Total of present inventory (in-use + spares).	1823	X			X

_____
A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter With Offeror Option
D. Entry Shall Be Made Prior To Solicitation Issuance

		A	B	C	D
5. Quantity of this procurement (Source Contracting Officer will enter this on line C.5.).	253*	X			X
6. Computation of Equation 2.		X			
D. REPAIR LABOR COST/FAILURE					
1. Base labor standard to detect, isolate, remove, replace (On-Equipment) IM or SSM will provide from LOG-K-260, 261, 262 series reports.	N/A				
2. Base labor rate $9.00 per hour. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships, dated 10 July 1967 (AFLCM/AFSCM 375-6).	$9.00	X			X
3. Base labor standard to repair (off equipment).			X		
4. RTS rate (IM or SSM will provide from LOG-K-260 series reports).	.998	X			X
5. Depot labor standard to repair.			X		
6. Depot labor standard to repair. When the NRTS rate is 0.70 the offeror shall provide in response to the solicitation.	N/A				
7. Depot labor rate $10.00 per hour. See D.2. for Source.	$10.00	X			X

A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter With Offeror Option
D. Entry Shall Be Made Prior To Solicitation Issuance

*1 year procurement. Enter average annual buy for a multi-year procurement.

		A	B	C	D
8. NRTS rate (SSM or IM will provide from LOG-K-260 series reports).	.002	X			X
9. Computation of Equation 5.		X			
E. REPAIR MATERIAL COST/FAILURE					
1. Base Material Cost Standard.			X		
2. RTS rate. See D.4. for source.		X			X
3. Depot Material Cost Standard.			X		
4. Depot Material Cost Standard - When the NRTS rate is 70% the offeror shall provide in response to the solicitation.	N/A				
5. NRTS rate. See D.8. for source.	.002	X			X
6. Computation of Equation 6.		X			
F. TRANSPORTATION COST/FAILURE					
1. Weight. This will be provided by the bidder in response to the solicitation.			X		
2. Standard Packing Labor Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships, dated 10 July 1967.	$0.1868 per lb.	X			X

A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter with Offeror Option
D. Entry Shall Be Made Prior To Solicitation Issuance

		A	B	C	D
3. Standard Packing Material Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships, dated 10 July 1967.	$0.0497 per lb.	X			X
4. Average Shipping Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/ AFSC Task Group on Program Management Work Relationships dated 10 July 1967.	$.0410 per lb.	X			X
5. NRTS rate. Obtain from D.8.	.002	X			X
6. Ratio of Packaged to Unpackaged Weight. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships dated 10 July 1967.	1.285	X			X
7. Computation of Equation 7.		X			
G. PREVENTIVE MAINTENANCE COSTS/UNIT					
1. Expected usage in hours of each item being procured. Obtain from B.1.		X			
2. Operating Hours per month. Obtain from C.2.	110 Hrs.	X			X
3. Preventive Maintenance manhours per month. Obtain from H.3.		X			

A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter with Offeror Option
D. Entry Shall Be Made Prior To Solicitation Issuance

		A	B	C	D
4. Base labor rate. Obtain from D.2	$9.00	X			X
5. Computation of Equation 8.		X			
H. PREVENTIVE MAINTENANCE MANHOURS PER MONTH					
1. Manhours to accomplish calibration action 1. Bidder provides in response to the solicitation.			X		
2. Number of times calibration must be performed. (This is calculated on a six-month interval.)	.1667	X			X
3. Computation of Equation 9.		X			
I. MAINTENANCE COST PER UNIT					
1. Expected number of failures during projected Inventory Usage period. Obtain from B.3.		X			
2. Labor Cost per Failure. Obtain from D.9.		X			
3. Material Cost per Failure. Obtain from E.6.		X			
4. Transportation Cost Per Failure. Obtain from F.7.		X			
5. Preventive Maintenance Cost per Unit. Obtain from G.5.		X			
6. Computation of Equation 1.		X			

A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter With Offeror Option
D. Entry Shall Be Made Prior To Solicitation Issuance

ACQUISITION COST EQUATION FORMAT

A = (UP)(N), + BTD

A = Acquisition Costs
UP = Unit Price
N = Number of Items to be Procured
BTD = Basic Technical Data

		A	B	C	D
1. Total Price (UP) (N)	_____	X			
Unit Price	_____		X		
Number of Units	253 each*	X			X
2. Basic Technical Data (BTD)	_____		X		
3. Total Acquisition Cost (A)	_____	X			

_____
A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't . Shall Enter With Offeror Option
D. Entry Shall Be Made Prior to Solicitation Issuance

*1 year procurement. 1,999 units for multi-year procurement

INITIAL LOGISTICS COST EQUATION FORMAT

I = TDMI + IMCI + TSTG

I = Initial Logistics
TDMI = Technical Data Mgt. Initial
IMCI = Item Mgt. Cost Initial
TSTG = Acceptance/Reliability Testing (GOVT.)

			A	B	C	D
1.	Technical Data Mgt. (TDMI)	_____	X			
	Number of Pages	_____		X		
	Number of copies distribution	1,000	X			X
	Cost per page for initial reproduction & distribution	$.004	X			X
	Cost per page for file maintenance 1st year	$14.00	X			X
	Number of Units	_____	X			X
2.	Item Mgt. Cost Initial (IMCI)	_____	X			
	Number of new items ("P" coded)	_____	X			
	One-time item entry costs (per new item)	$171.01	X			X
3.	Acceptance/Reliability Testing (TSTG)	_____	X			
4.	Total Initial Logistics Costs (I)	_____	X			

_____
A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter With Offeror Option
D. Entry Shall Be Made Prior to Solicitation Issuance

RECURRING COSTS EQUATION FORMAT

R = TDMR + IMCR + MC

R = Recurring Cost
TDMR = Technical Data Mgt. Recurring
IMCR = Item Mgt. Cost Recurring
MC = Maintenance Cost

		A	B	C	D
1.	Technical Data Mgt. Recurring (TDMR)		X		
	Number of pages			X	
	Cost per page for file maintenance 2nd and subsequent years	$6.00	X		X
	Number of Units	253 each	X		X
2.	Item Mgt. Cost Recurring (IMCR)		X		
	Number of new items (P coded)		X		
	Recurring Annual Material Mgt. Cost (Per new item)	$375.68	X		X
3.	Maintenance Cost (MC)		X		
4.	Total Recurring Cost (R)		X		

_____
A. Gov't. Shall Enter
B. Offeror Shall Enter
C. Gov't. Shall Enter With Offeror Option
D. Entry Shall Be Made Prior to Solicitation Issuance

PRICE ADJUSTMENT PROVISION

1. General - This contract was awarded on the basis of minimum Life Cycle Cost (LCC), where LCC = A + I + R as otherwise explained in that portion of this solicitation entitled, "Method of Bid Evaluation." In the above context, "A" is the total target price that shall be paid the contractor in the event that LCC_M is equal to or less than LCC_T, where LCC_M and LCC_T are defined as follows:

a. LCC_T is the preaward computation of Life Cycle Cost based upon the offeror's predicted values as otherwise set forth in the Quantitative Source Evaluation Format included as a part of the solicitation. $LCC_T = A_T + I_T + R_T$ where the subscript T denotes target.

b. LCC_M is the postaward computation of LCC, and is based upon all bid items identified as being subject to evaluation and variation such as the actual number of new items introduced into the Air Force inventory, and the actual value of such parameters as were observed during the Production Reliability Acceptance Test, i.e., MTBF, MTTR, etc. $LCC_M = A_T + I_M + R_M$ where the subscript M denotes measured values.

2. Payment

a. The final amount to be paid the contractor shall be A_T if LCC_M is equal to or less than LCC_T. If LCC_M is greater than LCC_T, then the final amount to be paid the contractor shall be less than A_T because the contractor has provided hardware that does not meet his predictions which were the basis for award. In the event that LCC_M is greater than LCC_T, then the final contract price shall be computed as Final Price (FP) =

$$\left[A_T\right]\left[1 - \left(\frac{3}{10} + \frac{A_T}{3LCC_T}\right)\left(\frac{LCC_M - LCC_T}{LCC_T}\right)\right]$$

3. Disagreements. If the contractor and the contracting officer fail to agree upon the total final price within 60 days after the date on which the data required by the above are to be submitted, or within such further time as may be specified by the contracting officer, such failure to agree shall be deemed to be a dispute concerning a question of fact

within the meaning of the "Disputes" clause of this contract and the contracting officer shall promptly issue a decision thereunder.

4. Termination. If this contract is terminated prior to establishment of the total final price, prices of supplies or services subject to price revision under the clause shall be established pursuant to this clause for (i) completed supplies accepted by the Government and services performed and accepted by the Government, and (ii) in the event of a partial termination, supplies and services which are not terminated. The termination shall be otherwise accomplished pursuant to other applicable provisions of this contract.

5. Equitable Adjustments Under Other Clauses. If an equitable adjustment in the contract price is made under any other clause of this contract before the total final price is established, the adjustment shall be made in the total LCC target cost and in the minimum dollar limit on the total adjusted final price.

BID EVALUATION

Tables 3B and 3C present the data from six "bidders" and the evaluation of bids. The government-supplied data are actual figures from the specified procurement with a few minor changes to permit evaluation on a multi-year basis. The contractor-supplied data are fictitious. The present value calculations also have been added.

Bidder F received the award.

Table 3B

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
A. MEAN TIME BETWEEN FAILURE (MTBF)						
1. Time between failure cited by bidder in response to the solicitation in hours.	2400	3000	2500	2800	3600	2500
2. Discrimination ratio cited in solicitation (source is Test Plan II Mil. Std.781).	1.5	1.5	1.5	1.5	1.5	1.5
3. Computation of Equation 4.	1600	2000	1666.6667	1866.6667	2400	1666.6667
B. EXPECTED NUMBER OF FAILURES IN PROJECTED INVENTORY USAGE PERIOD PER ITEM BEING PROCURED						
1. Expected usage (in hours) of each item being procured. (Obtain from line C.6.)	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732
2. MTBF (Mean Time Between Failure). Obtain from Line A.3.	1600	2000	1666.6667	1866.6667	2400	1666.6667
3. Computation of Equation 3.	5.4502	4.3601	5.2322	4.6716	3.6334	5.2322
C. EXPECTED USAGE (IN HOURS) OF EACH ITEM BEING PROCURED						
1. Projected inventory usage period in months (IM or SSM will determine by review of program documents).	126 months	126 months	126 months	126 months	126 months	126 months
2. Hours of operation per mo. (IM or SSM will determine by review of program documents).	110 hours	110 hours	110 hours	110 hours	110 hours	110 hours

(Continued)

Table 3B (Cont'd)

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
3. Total quantity of in-use items.	1566	1566	1566	1566	1566	1566
4. Total of present inventory (in-use + spares).	1823	1823	1823	1823	1823	1823
5. Average quantity of this procurement per year of multi-year procurement (Source Contracting Officer will enter this on line C.5.).	666	666	666	666	666	666
6. Computation of Equation 2.	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732
D. REPAIR LABOR COST/FAILURE						
1. Base labor standard to detect, isolate, remove, replace (On-Equipment) IM or SSM will provide from LOG-K-260, 261, 262 series reports.	N/A	N/A	N/A	N/A	N/A	N/A
2. Base labor rate $9.00 per hour. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships, dated 10 July 1967 (AFLCM/AFSCM 375-6).	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
3. Base labor standard to repair (off equipment).	3 M/H	3.5 M/H	3 M/H	4 M/H	2.5 M/H	3 M/H

(Continued)

Table 3B (Cont'd)

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
4. RTS rate IM or SSM will provide from LOG-K-260 series reports.	.998	.998	.998	.998	.998	.998
5. Depot labor standard to repair.	6 M/H	8.5 M/H	6 M/H	9 M/H	7.5 M/H	8 M/H
6. Depot labor standard to repair. When the NRTS rate is > 0.70 the offeror shall provide in response to the solicitation.	N/A	N/A	N/A	N/A	N/A	N/A
7. Depot labor rate $10.00 per hour. See D.2. for source.	$10.00	$10.00	$10.00	$10.00	$10.00	$10.00
8. NRTS rate SSM or IM will provide from LOG-K-260 series reports.	.002	.002	.002	.002	.002	.002
9. Computation of Equation 5.	$27.0660	$31.6060	$27.0660	$36.1080	$22.6050	$27.1060
E. REPAIR MATERIAL COST/FAILURE						
1. Base Material Cost Standard.	$10.52	$8.36	$6.94	$6.78	$7.23	$9.24
2. RTS rate. See D.4. for source.	.998	.998	.998	.998	.998	.998
3. Depot Material Cost Standard.	$24.20	$26.20	$24.10	$28.90	$29.60	$24.10
4. Depot Material Cost Standard - When the NRTS rate is > 0.70% the offeror shall provide in response to the solicitation.	N/A	N/A	N/A	N/A	N/A	N/A

(Continued)

Table 3B (Cont'd)

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
5. NRTS rate - See D.8. for source.	.002	.002	.002	.002	.002	.002
6. Computation of Equation 6.	$10.5474	$8.3957	$6.9743	$6.8242	$7.2747	$9.2697
F. TRANSPORTATION COST/FAILURE						
1. Weight. This will be provided by the bidder in response to the solicitation.	34	33	34	35	35	34
2. Standard Packing Labor Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships, dated 10 July 1967.	$0.1868/lb.	$0.1868/lb.	$0.1868/lb.	$0.1868/lb.	$0.1868/lb.	$0.1868/lb.
3. Standard Packing Material Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships dated 10 July 1967.	$.0497/lb.	$.0497/lb.	$.0497/lb.	$.0497/lb.	$.0497/lb.	$.0497/lb.
4. Average Shipping Rate. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships dated 10 July 1967.	$.0410/lb.	$.0410/lb.	$ .410/lb.	$.0410/lb.	$.0410/lb.	$.0410/lb.

(Continued)

Table 3B (Cont'd)

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
5. NRTS rate. Obtain from D.8.	.002	.002	.002	.002	.002	.002
6. Ratio of Packaged to Unpackaged Weight. Obtain from Equation 7. Source, report - Phase II, Panel 31, Joint AFLC/AFSC Task Group on Program Management Working Relationships dated 10 July 1967.	1.285	1.285	1.285	1.285	1.285	1.285
7. Computation of Equation 7.	$0.0393	$0.0382	$0.0393	$0.0405	$0.0405	$0.0393
G. PREVENTIVE MAINTENANCE COSTS/ UNITS						
1. Expected usage in hours of each item being procured. Obtain from B.1.	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732	8720.2732
2. Operating hours per month. Obtain from C.2.	110	110	110	110	110	110
3. Preventive maintenance man-hours per month. Obtain from H.3.	0.3334	0.1667	0.1834	0.1500	0.2334	0.2501
4. Base labor rate. Obtain from D.2.	$9.00	$9.00	$9.00	$9.00	$9.00	$9.00
5. Computation of Equation 8.	$237.8732	$118.9366	$130.8516	$107.0215	$166.5255	$178.4405

(Continued)

Table 3B (Cont'd)

Bid Data - Case 3 - Multi-Year Procurement

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
H. PREVENTIVE MAINTENANCE MAN HOURS PER MONTH						
1. Manhours to accomplish calibration.action 1. Bidder provides in response to the solicitation.	2.0	1.0	1.1	0.9	1.4	1.5
2. Number of times calibration must be performed. (This is calculated on a six-month interval.)	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667
3. Computation of Equation 9.	0.3334	0.1667	0.1834	0.1500	0.2334	0.2501
I. MAINTENANCE COST PER UNIT						
1. Expected number of failures during Projected Inventory Usage Period. Obtain from B.3.	5.4502	4.3601	5.2322	4.6716	3.6334	5.2322
2. Labor Cost per Failure. Obtain from D.9.	$27.0660	$31.6060	$27.0660	$36.1080	$22.6050	$27.1060
3. Material Cost per Failure. Obtain from E.6.	$10.5474	$8.3957	$6.9743	$6.8242	$7.2747	$9.2697
4. Transportation Cost Per Failure. Obtain from F.7.	$0.0393	$0.0382	$0.0393	$0.0405	$0.0405	$0.0393
5. Preventive Maintenance Cost per Unit. Obtain from G.5.	$237.8732	$118.9366	$130.8516	$107.0215	$166.5255	$178.4405
6. Computation of Equation 1.	$443.0879	$293.5146	$309.1629	$307.5926	$275.2376	$368.9711

Table 3C

Bid Evaluation - Case 3 - Multi-Year Procurement

ACQUISITION COST EQUATION FORMAT

A = (UP) (N) + BTD

A = Acquisition Costs
UP = Unit Price
N = Number of Items to be Procured
BTD = Basic Technical Data

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
1. Total Price (UP) (N)	$2,594,122.29	$3,846,875.60	$2,863,827.37	$3,480,259.00	$4,020,888.55	$2,610,094.30
Unit Price	$ 1,297.71	$ 1,924.40	$ 1,432.63	$ 1,741.00	$ 2,011.45	$ 1,305.70
No. of Units	1,999 each	1,999 each	1,999 each	1,999 each	1,999 each	1,999 each
2. Basic Tech. Data (BTD)	$ 1,600.00	$ 1,700.00	$ 1,300.00	$ 1,500.00	$ 1,200.00	$ 1,300.00
3. Tot. Acquisition Cost (A)	$2,595,722.29	$3,848,575.60	$2,865,127.37	$3,481,759.00	$4,022,088.55	$2,611,394.30

(continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

INITIAL LOGISTICS COST EQUATION FORMAT

I = TDMI + IMCI + TSTG

I = Initial Logistics
TDMI = Technical Data Mgt. Initial
IMCI = Item Mgt. Cost Initial
TSTG = Acceptance/Reliability Testing (GOVT.)

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
1. Technical Data Mgt (TDMI)	$ 6,012.00	$ 5,490.00	$ 5,310.00	$ 6,696.00	$ 5,958.00	$ 6,624.00
Number of Pages	334	305	295	372	331	368
Number of copies distribution	1,000	1,000	1,000	1,000	1,000	1.000
Cost per page for initial reproduction & distribution	$.004	$.004	$.004	$.004	$.004	$.004
Cost per page for file maintenance 1st year	$14.00	$14.00	$14.00	$14.00	$14.00	$14.00
Number of Units	1999	1999	1999	1999	1999	1999
2. Item Mgt. Cost Initial (IMCI)	$10,602.62	$10,602.62	$13,509.79	$14,877.87	$11,799.69	$12,141.71
Number of new items ("P" Coded)	62	62	79	87	69	71
One-time item entry costs (per new item)	$ 171.01	$ 171.01	$ 171.01	$ 171.01	$ 171.01	$ 171.01
3. Acceptance/Reliability Testing (TSTG) (Bid MTBF θ_o - 2250) x ($2.9866)	$ 149.33	$ 2,239.95	$ 746.65	$ 1,642.63	$ 4,031.91	$ 447.99
4. Total Initial Logistics Costs (I)	$16,763.95	$18,332.57	$19,566.44	$23,216.50	$21,789.60	$19,213.70

(Continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

RECURRING COSTS EQUATION FORMAT

R = TDMR + IMCR + MC

R = Recurring Cost
TDMR = Technical Data Mgt. Recurring
IMCR = Item Mgt. Cost Recurring
MC = Maintenance Cost

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
1. Technical Data Mgt. Recurring (TDMR)	$ 23,046.00	$ 21,045.00	$ 20,355.00	$ 25,668.00	$ 22,839.00	$ 25,392.00
Number of pages	334	305	295	372	331	368
Cost per page for file maintenance 2nd and subsequent years *	$6.00	$6.00	$6.00	$6.00	$6.00	$6.00
Number of Units	1999 each	1999 each	1999 each	1999 each	1999 each	1999 each
2. Item Mgt Cost Recurring (IMCR)	$291,152.00	$291,152.00	$ 370,984.00	$ 408,552.00	$324,024.00	$ 333,416.00
Number of new items (P coded)	62	62	79	87	69	71
Recurring Annual Material Mgt. Cost (Per new item)**	$ 375.68	$ 375.68	$ 375.68	$ 375.68	$ 375.68	$ 375.68
3. Maintenance Cost (MC) (I.6XUnits)	$885,732.71	$586,735.69	$ 618,016.64	$ 614,877.61	$550,199.96	$ 737,573.23
4. Total Recurring Cost (R)	$1,199,930.71	$898,932.69	$1,009,355.64	$1,049,097.61	$897,0C2.96	$1,096,381.23

*Cost per page total = $\left[\frac{PIUP}{12} - 1 + (MYP-1)\right]$ ($6.00)

**Cost per item total = $\left[\frac{PIUP}{12} + (MYP-1)\right]$ ($375.68)

MYP = Years in multi-year procurement

(Continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

LIFE CYCLE COSTS EQUATION FORMAT

LCC = A+I+R LCC = Total Life Cycle Costs
A = Acquisition Cost
I = Initial Logistics Costs
R = Recurring Costs

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
1. Acquisition Cost	$2,595,722.29	$3,848,575.60	$2,865,127.37	$3,481,759.00	$4,022,088.55	$2,611,394.30
2. Initial Log. Cost	$ 16,763.95	$ 18,332.57	$ 19,566.44	$ 23,216.50	$ 21,789.60	$ 19,213.70
3. Recurring Costs	$1,199,930.71	$ 898,932.69	$1,009,355.64	$1,049,097.61	$ 897,062.96	$1,096,381.23
4. Total Life Cycle Costs	$3,812,416.95	$4,765,840.86	$3,894,049.45	$4,454,073.11	$4,940,941.11	$3,726,989.23

(continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

PRESENT VALUE CALCULATION FORMAT*

		Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
Acquisition Cost							
1st Yr:	Units	253	253	253	253	253	253
	Price	$ 1,297.71	$ 1,924.40	$ 1,432.63	$ 1,741.00	$ 2,011.45	$ 1,305.70
	Factor	0.954	0.954	0.954	0.954	0.954	0.954
	Present Value	$ 313,217.88	$ 464,477.03	$ 345,782.44	$ 420,211.24	$ 485,487.59	$ 315,146.36
2nd Yr:	Units	300	300	300	300	300	300
	Price	$ 1,297.71	$ 1,924.40	$ 1,432.63	$ 1,741.00	$ 2,011.45	$ 1,305.70
	Factor	0.867	0.867	0.867	0.867	0.867	0.867
	Present Value	$ 337,534.37	$ 500,536.44	$ 372,627.06	$ 452,834.10	$ 523,178.15	$ 339,612.57
3rd Yr:	Units	1.446	1.446	1.446	1.446	1.446	1.446
	Price	$ 1,297.71	$ 1,924.40	$ 1,432.63	$ 1,741.00	$ 2,011.45	$ 1,305.70
	Factor	0.788	0.788	0.788	0.788	0.788	0.788
	Present Value	$1,478,673.06	$2,192,753.73	$1,632,407.39	$1,983,778.97	$2,291,942.68	$1,487,777.25
Basic Tech. Data							
	Price	$ 1,600.00	$ 1,700.00	$ 1,300.00	$ 1,500.00	$ 1,200.00	$ 1,300.00
	Factor	0.954	0.954	0.954	0.954	0.954	0.954
	Present Value	$ 1,526.40	$ 1,621.80	$ 1,240.20	$ 1,431.00	$ 1,144.80	$ 1,240.00
Initial Log. Cost Tech. Data Mgmt.							
	Cost	$ 6,012.00	$ 5,490.00	$ 5,310.00	$ 6,696.00	$ 5,958.00	$ 6,624.00
	Factor	0.954	0.954	0.954	0.954	0.954	0.954
	Present Value	$ 5,735.45	$ 5,237.46	$ 5,065.74	$ 6,387.98	$ 5,683.93	$ 6,319.30
Initial Item Mgmt.							
	Cost	$ 10,602.62	$ 10,602.62	$ 13,509.79	$ 14,877.87	$ 11,799.69	$ 12,141.71
	Factor	0.954	0.954	0.954	0.954	0.954	0.954
	Present Value	$ 10,114.90	$ 10,114.90	$ 12,888.34	$ 14,193.49	$ 11,256.90	$ 11,583.19

*Not included in original RFP. Included here IAW DoD Instruction 7041.3, 26 February 1969.

(continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

PRESENT VALUE CALCULATION FORMAT (Cont'd)*

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
Testing						
Total Cost	$ 149.33	$ 2,239.95	$ 746.65	$ 1,642.63	$ 4,031.91	$ 447.99
Fraction 1st Yr = 253/1,999						
Factor	0.1266	0.1266	0.1266	0.1266	0.1266	0.1266
	0.954	0.954	0.954	0.954	0.954	0.954
Present Value	$ 18.04	$ 270.59	$ 90.20	$ 198.43	$ 487.05	$ 54.12
Fraction 2nd Yr = 300/1,999						
Factor	0.1501	0.1501	0.1501	0.1501	0.1501	0.1501
	0.867	0.867	0.867	0.867	0.867	0.867
Present Value	$ 19.43	$ 291.42	$ 97.14	$ 213.71	$ 524.55	$ 58.28
Fraction 3rd Yr = 1,446/1,999						
Factor	0.7233	0.7233	0.7233	0.7233	0.7233	0.7233
	0.788	0.788	0.788	0.788	0.788	0.788
Present Value	$ 85.12	$ 1,276.77	$ 425.59	$ 936.30	$ 2,298.19	$ 255.35
Recurring Costs Tech. Data Mgmt. Ending Year, N_1 = PIUP/12 -1+(MYP)						
Total Cost	$ 23,046.00	$ 21,045.00	$ 20,355.00	$ 25,668.00	$ 22,839.00	$ 25,392.00
Factor, 2nd thru N_1 Yrs = 7.149/12	13	13	13	13	13	13
x 0.954	0.5683	0.5683	0.5683	0.5683	0.5683	0.5683
Present Value	$ 13,097.04	$ 11,959.87	$ 11,567.75	$ 14,587.12	$ 12,979.40	$ 14,430.27

*Not included in original RFP. Included here IAW DoD Instruction 7041.3, 26 February 1969.

(continued)

Table 3C (Cont'd)

Bid Evaluation - Case 3 - Multi-Year Procurement

PRESENT VALUE CALCULATION FORMAT (Cont'd)*

	Bid A	Bid B	Bid C	Bid D	Bid E	Bid F
Item Management Cost						
Ending Year, N_2=						
$\frac{PIUP}{12}$ + (MYP)	14	14	14	14	14	14
Total Cost	$ 291,152.00	$ 291,152.00	$ 370,984.00	$ 408,552.00	$ 324,024.00	$ 333,416.00
Factor, 2nd through N_2 Years = $\frac{7.453}{13}$ x 0.954	0.5469	0.5469	0.5469	0.5469	0.5469	0.5469
Present Value	$ 159,231.03	$ 159,231.03	$ 202,891.15	$ 223,437.09	$ 177,208.73	$ 182,345.21
Maintenance Cost						
Item Life, years	11	11	11	11	11	11
1st Year, Units	253	253	253	253	253	253
Units x I.6	$ 112,101.24	$ 74,259.19	$ 78,218.21	$ 77,820.93	$ 69,635.11	$ 93,349.69
Factor = $\frac{6.815}{11}$	0.6195	0.6195	0.6195	0.6195	0.6195	0.6195
Present Value	$ 69,446.72	$ 46,003.57	$ 48,456.18	$ 48,210.07	$ 43,138.95	$ 57,830.13
2nd Year, Units	300	300	300	300	300	300
Units x I.6	$ 132,926.37	$ 88,054.38	$ 92,748.87	$ 92,277.78	$ 82,571.28	$ 110,691.33
Factor = $\frac{6.815}{11}$						
x 0.954	0.5910	0.5910	0.5910	0.5910	0.5910	0.5910
Present Value	$ 78,559.48	$ 52,040.14	$ 54,814.58	$ 54,536.17	$ 48,799.63	$ 65,418.58
3rd Year, Units	1,446	1,446	1,446	1,446	1,446	1,446
Units x I.6	$ 640,705.10	$ 424,422.11	$ 447,049.55	$ 444,778.90	$ 397,993.57	$ 533,532.21
Factor = $\frac{6.815}{11}$						
x 0.867	0.5371	0.5371	0.5371	0.5371	0.5371	0.5371
Present Value	$ 344,122.71	$ 227,957.12	$ 240,110.31	$ 238,890.75	$ 213,762.35	$ 286,560.15
TOTAL PRESENT VALUE	$2,811,381.63	$3,673,771.87	$2,928,464.07	$3,459,846.42	$3,817,892.90	$2,768,630.76

*Not included in original RFP. Included here IAW DoD Instruction 7041.3, 26 February 1969.

DISCUSSION

The use of LCC produced a different result than would have occurred with a low price criterion. The Case has also been included as an example of a rather complete LCC evaluation format.

Training was not included. However, the training evaluation format shown in Case 1, appropriately modified, could be added to a Case of this type.

The technique of post-award testing of performance criteria is a common one. It is feasible for those procurements in which delivery is made over an extended period of time or in which the testing period is short enough to be completed prior to final contract payment.

The Final Price equation in the Price Adjustment Provision is structured so that part of the difference between the pre-award and post-award computations of LCC is absorbed by the government. Since the extent of penalty provisions is an important factor in LCC procurement, that equation will be discussed.

It is not always in the interest of the government to insist on a penalty arrangement which fully compensates it for the difference between "measured" LCC (established by test and/or post-award computation) and "target" LCC (the LCC figure used in award of the contract). When it is possible for target LCC to exceed target price by a wide margin, it may be possible for target LCC and measured LCC to differ by a huge amount. If a 100% penalty provision realistically has the potential of causing competent firms to withdraw from the competition or to include huge contingencies in their prices, a cost-sharing arrangement may be in order.

In this Case the government and the contractor agree to share the amount by which measured LCC exceeds target LCC. (If measured LCC is not greater than target LCC, there is no price adjustment.) The sharing ratio depends on the relationship between target price and target LCC. If target LCC is 10% greater than target price, the contractor assumes responsibility for about 55% of the difference between measured LCC and target LCC. If target LCC is ten <u>times</u> target price, the contractor assumes responsibility for 3-1/3% of the same difference. (See Figure 3D.)

Another portrayal of the penalty provision is shown in Figure 3E. For a given ratio of target LCC to target price, the percentage price adjustment is linear with respect to the ratio between measured LCC and target LCC.

Figure 3D

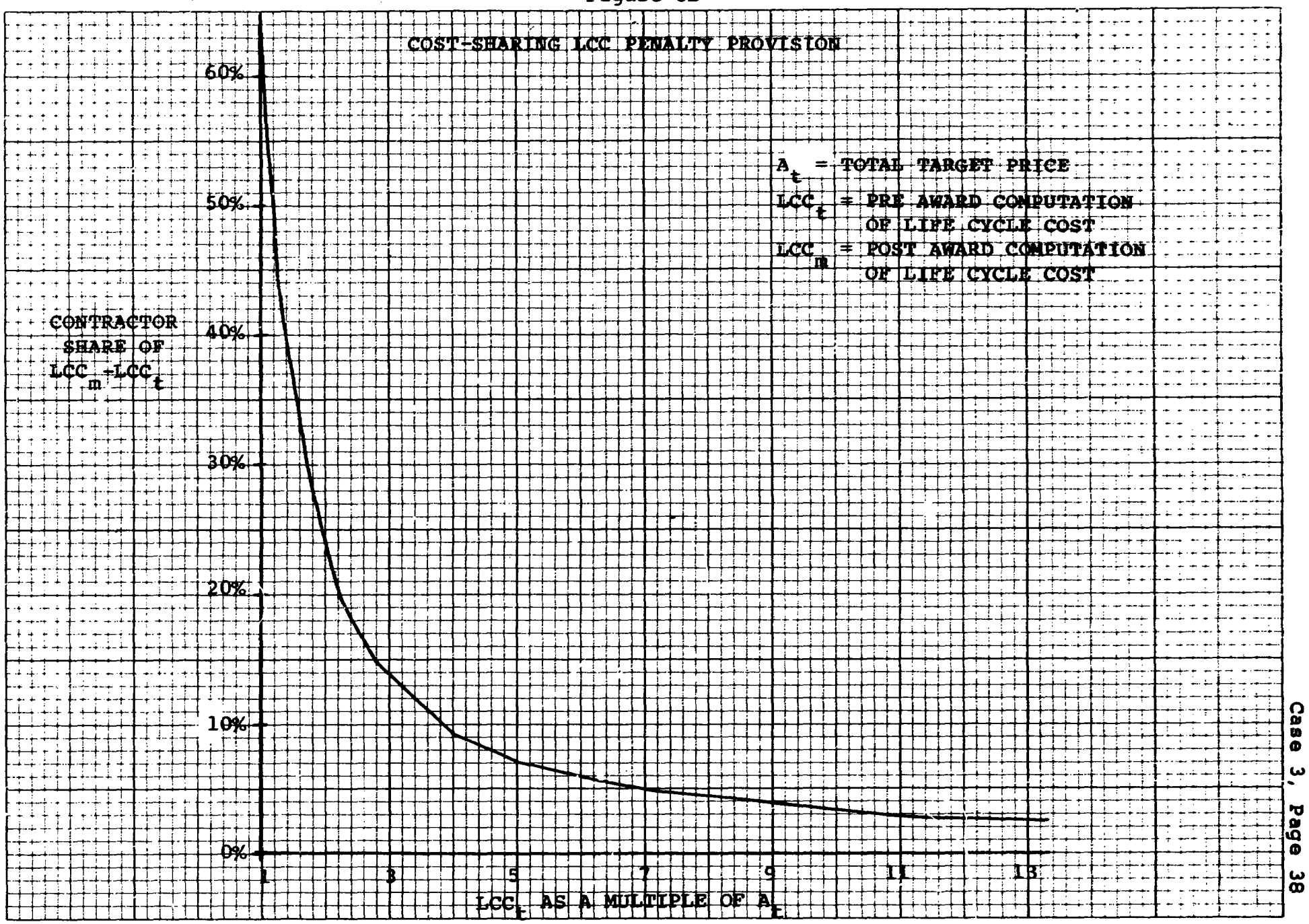
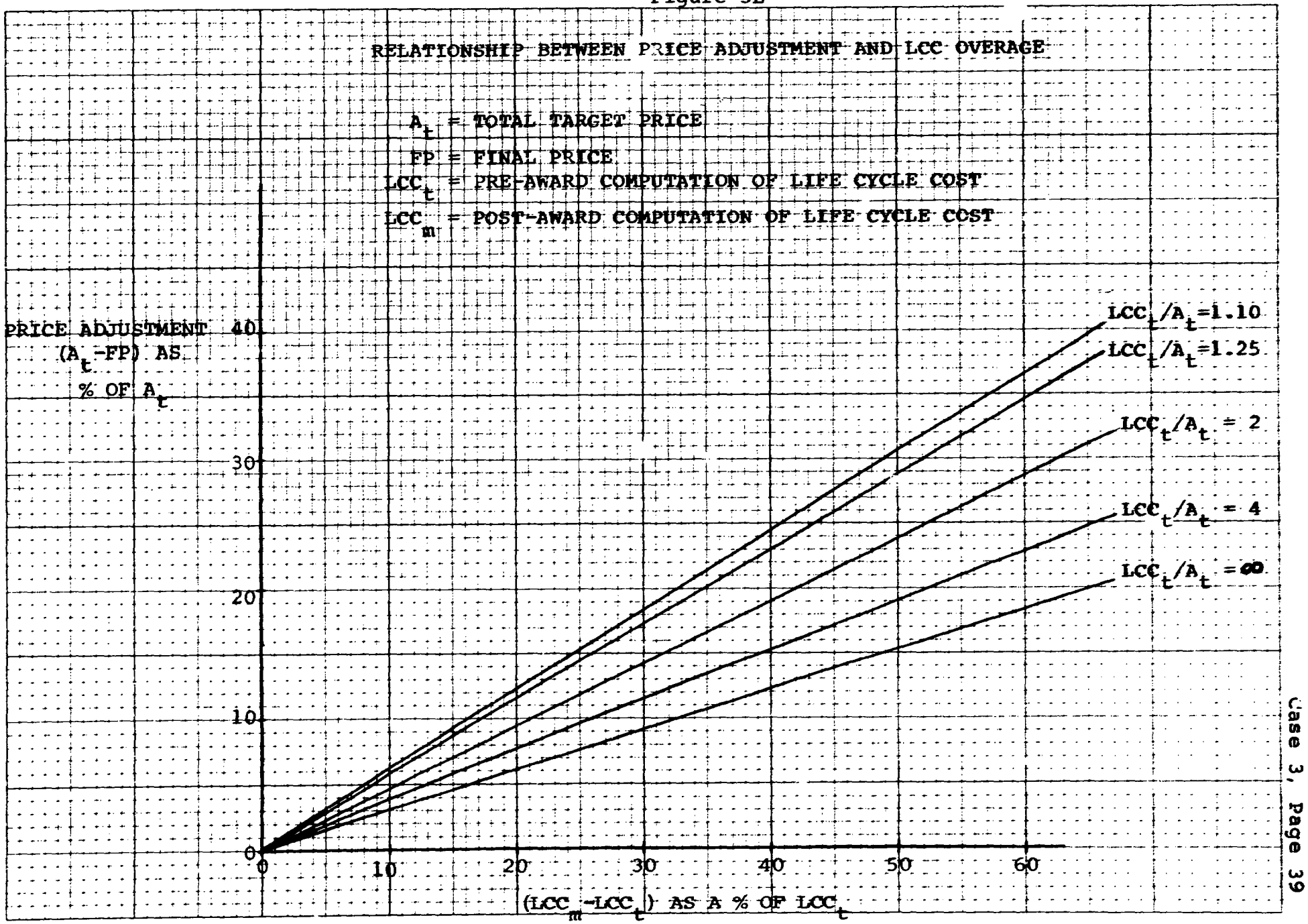

COST-SHARING LCC PENALTY PROVISION
A_t = TOTAL TARGET PRICE
LCC_t = PRE AWARD COMPUTATION OF LIFE CYCLE COST
LCC_m = POST AWARD COMPUTATION OF LIFE CYCLE COST
CONTRACTOR SHARE OF $LCC_m - LCC_t$
60%
50%
40%
30%
20%
10%
0%
1
3
5
7
9
11
13
LCC_t AS A MULTIPLE OF A_t

Figure 3E


RELATIONSHIP BETWEEN PRICE ADJUSTMENT AND LCC OVERAGE
A_t = TOTAL TARGET PRICE
FP = FINAL PRICE
LCC_t = PRE-AWARD COMPUTATION OF LIFE CYCLE COST
LCC_m = POST-AWARD COMPUTATION OF LIFE CYCLE COST
PRICE ADJUSTMENT (A_t-FP) AS % OF A_t
40
30
20
10
0
0
10
20
30
40
50
60
$(LCC_m - LCC_t)$ AS A % OF LCC_t
LCC_t/A_t=1.10
LCC_t/A_t=1.25
LCC_t/A_t = 2
LCC_t/A_t = 4
LCC_t/A_t = ∞

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PD-SANE-6625-115

15 August 1968

PURCHASE DESCRIPTION

OSCILLOSCOPE, 15 MEGAHERTZ

1. SCOPE

1.1 This purchase description covers a solid state oscilloscope for field and laboratory use.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the description to the extent specified herein:

SPECIFICATIONS

Military

MIL-E-17555	Electronic And Electrical Equipment And Associated Repair Parts; Preparation For Delivery Of

STANDARDS

Military

MIL-STD-781	Reliability Tests Exponential Distribution
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-831	Test Reports, Preparation of
MS 3345-1	Flange, Split Mounting Meter Time Totalizing
MS 17321-4	Meter, Time Totalizing Miniature, Digital 28 Volts DC

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Minimum requirements. The requirements of this purchase description reflect the minimum characteristics and accuracy. Items that provide additional characteristics, greater accuracy, and improved performance will be acceptable. These items shall be tested to the manufacturers specifications.

3.2 Design and construction.

3.2.1 Design. All circuitry shall exhibit sufficient stability of operating parameters to maintain calibration within the allowable tolerance, without resetting any internal controls, for the environmental and reliability conditions as specified herein. The circuitry of this equipment shall be designed to preclude the necessity of sorting or selecting of any component part from within the stated tolerance of such part during construction, testing, or subsequent maintenance actions.

3.2.2 Construction. Except for the cathode ray tube (crt), the instrument shall be of solid state miniaturized construction. The construction shall allow maximum accessibility to internal parts and subassemblies.

3.2.3 Adjustments. Adjustments or compensating devices, capable of restoring the circuitry to the specified tolerances shall be provided. These devices must be provided for any circuitry, function, or parameter in which the combined time of shelf life and usage for a period of six months would cause the instrument to exceed the specified tolerances.

3.2.4 Failure. A failure as used in this purchase description (PD) is any need to recalibrate by any adjustment not considered an operating control, or any replacement of a component or components during testing, in order for the instrument to meet the requirements of this purchase description. The Government reserves the final authority, after due consideration, to determine a failure as defined in this PD.

3.3 Functional description. The oscilloscope, hereafter called instrument, shall be a self-contained unit and shall provide a

visual display of any electrical waveform over a frequency range from direct current (DC) to not less than 15 megahertz (MHz).

3.4 Composition. The instrument shall consist of the following items and other component parts specified herein and as required to make up a complete equipment:

a. Power supply (3.5.1).
b. Visual display (3.5.2).
c. Vertical section (3.5.3).
d. Horizontal section (3.5.4).
e. Time base section (3.5.5).
f. Voltage calibrator (3.5.6).
g. Accessories (3.5.7).

3.5 Performance requirements.

3.5.1 Power supply. The power supply shall be capable of regulating the supply voltages for all power sources specified in 3.6.

3.5.2 Visual display.

3.5.2.1 CRT. The crt shall have a phosphor P31 screen, unless otherwise specified (see 6.2). The viewing area shall be not less than 8 centimeters (cm) horizontal and 4 cm vertical.

3.5.2.1.1 Graticule. An internal, no parallax graticule shall be provided. The graticule shall be precision ruled in squares, 10 horizontal divisions (div) and 8 vertical div. These div shall be not greater than 1 cm square or not less than 8 millimeters (mm) square. The center horizontal and vertical lines shall be equally subdivided into increments, 5 increments for each horizontal and vertical div.

3.5.2.2 Geometry. The horizontal and vertical geometry shall not deviate more than $\pm$ ½ increment over the graticule area.

3.5.2.3 Intensity. The intensity shall be such that a square wave input with a rise time of 25 nanoseconds (nsec) at 1 MHz, having 5 div of vertical deflection, shall be visible with the horizontal sweep speed set to 10 microseconds per div (usec/div). The intensity control shall provide both greater than and less than optimum intensity.

3.5.2.4 Focus and astigmatism. These controls shall be capable of adjusting the display so that an input of any frequency from DC to 15 MHz is sharply focused and uniform in intensity and trace width over the entire viewing area.

3.5.3 Vertical section. The vertical section shall be dual channel. All or part of the vertical section may be a plug-in subassembly. Not more than one vertical plug-in subassembly shall be used to meet the requirements specified herein.

3.5.3.1 Delay circuit. The vertical amplifier shall contain a delay circuit that is capable of delaying the input signal until the sweep has started and the crt is unblanked. The entire leading edge of the input signal shall be visible.

3.5.3.2 Controls. The following controls shall be mounted on the front panel:

a. Coupling control for each channel.
b. Step attenuator for each channel.
c. Variable attenuator for each channel.
d. Vertical position control for each channel.
e. Polarity inverting control for channel 1 or channel 2.
f. A function switch.

3.5.3.2.1 Coupling controls. The coupling control shall provide for alternating current (AC) and DC coupling. When AC coupled, an input signal of 300 volts DC, on any sensitivity setting, shall not move the crt beam out of range of the vertical position control for more than five seconds. The coupling control shall have a ground position. When in the ground position, the input signal circuit shall be opened and input to the vertical amplifier grounded.

3.5.3.2.2 Step attenuator. The step attenuator shall provide calibrated sensitivity ranges from 10 millivolts (mv) per div (mv/div) to 20 volts per div (volts/div) in a 1-2-5 sequence. An attenuator probe may be used to obtain the required volts/div ranges.

3.5.3.2.3 Variable attenuator. The variable attenuator shall be capable of attenuating the input signal from 0 to at least 60 percent on any step attenuator sensitivity setting. A DC balance control mounted on the front panel shall permit balancing of the

variable attenuator so that not more than ± 1 increment of trace shift occurs when the vertical gain is varied. The DC balance control may be a screwdriver adjustment.

3.5.3.2.4 Vertical position control. The vertical position control shall be capable of vertically positioning the trace over the entire viewing area of the crt on any step attenuator sensitivity setting.

3.5.3.2.5 Polarity inverting switch. The polarity inverting switch shall be capable of reversing the polarity of the channel 1 or channel 2 input signal.

3.5.3.2.6 Function switch. The function switch shall select the following modes of operation:

a. Channel 1 only.

b. Channel 2 only.

c. Alternate, electronic switching of channel 1 and 2 on alternate sweeps.

d. Chopped, electronic switching of channel 1 and 2 at a minimum rate of 100 kilohertz (kHz).

e. Algebraic addition of channel 1 and 2.

3.5.3.3 Frequency response. The combined frequency response of the instrument and plug-in unit, AC coupled, with or without an attenuator probe, shall be not more than 3 decibels (db) down at 20 Hertz (Hz) and 15 MHz. The response shall roll off smoothly; aberrations on the frequency response curve shall be not greater than ± 0.25 db as the frequency is varied across the specified limits. From 20 Hz to 15 MHz the display shall be accurate within ± 3 percent.

3.5.3.4 Rise time. With a fast rise (3 nsec) square wave applied, the combined rise time of the instrument and plug-in unit, with or without an attenuator probe, shall be not greater than 25 nsec between the 10 and 90 percent points.

3.5.3.5 Drift. Drift shall not be greater than ±1 division within 1 hour following a 6 div step function, when DC coupled.

3.5.3.6 Overshoot and ringing. Aberrations shall not be greater than 3 percent, when a fast rise (3 nsec) square wave is applied.

3.5.3.7 Input impedance. The input impedance of each channel without an attenuator probe shall be 1 megohm, ±1 percent, paralleled by not more than 40 picofarads (pf). The input capacitance of each channel shall be adjustable to compensate for variations in input characteristics between channel 1 and 2.

3.5.3.8 Vertical input connectors. The vertical input connectors shall be typed BNC female mounted on the front panel.

3.5.4 Horizontal section. The horizontal section shall consist of a horizontal amplifier and a horizontal position control.

3.5.4.1 Horizontal amplifier. The horizontal amplifier shall provide the following:

a. Frequency response from DC to 500 KHz at the 3 db points.

b. A variable attenuator which provides continuously variable sensitivity ranges from 1 volt/div to 10 volts/div.

c. A sweep length of at least 10 div, with the sweep magnifier off.

d. An input impedance of at least 300 kilohms ± 5 percent, paralleled by not more than 50 pf.

3.5.4.2 Horizontal position control. The horizontal position control shall be capable of moving the trace at least 5 div in both horizontal directions.

3.5.4.3 Horizontal amplifier input connector. The horizontal amplifier input connector shall be a type BNC female, mounted on the front panel.

3.5.5 Time base section.

3.5.5.1 Sweep ranges. A control mounted on the front panel shall provide calibrated sweep ranges from 0.5 usec/div to 0.5 seconds per div (sec/div) in a 5-10-20 sequence. Accuracy of the sweep shall be within ±3 percent over the center 8 div of the crt graticule.

3.5.5.2 Time base variable control. A control mounted on the front panel shall vary the sweep time on any sweep range. The overall range of the adjustment shall be from 0.5 usec/div to not less than 1.25 sec/div.

3.5.5.3 Sweep linearity. The horizontal sweep shall be linear to within ±1 increment between the second and tenth vertical graticule lines. Variations in sweep linearity over the remainder of the crt graticule shall not exceed 2 increments.

3.5.5.4 Sweep magnifier. A front panel control shall provide sweep expansion by a factor of 5 or 10. The accuracy of the expanded sweep shall be within ± 5 percent, when measured between the second and ninth vertical graticule lines. When the sweep magnifier is turned on and off, the portion of the display positioned under the center vertical graticule shall not shift more than:

a. ± 1 increment if a X5 magnifier is provided.

b. ± 1/2 div if a X10 magnifier is provided.

3.5.5.5 Gate output. The gate output shall be provided through a BNC connector mounted on the front panel. The gate shall be at least ± 0.3 volts peak into 10 kilohms and shall be coincident with, as long as, and retain the accuracy of the sweep voltage.

3.5.5.6 Trigger circuit. A front panel control shall provide the following trigger modes:

a. Internal.

b. External, AC and DC coupled.

c. AC low frequency reject.

d. Automatic.

3.5.5.6.1 Trigger slope and level. Front panel controls shall provide selection of the trigger slope and level for internal and external triggering signals. On any vertical sensitivity setting, the instrument shall be capable of triggering on the following input signals:

a. From 16 percent to 98 percent of the leading and trailing edge of a positive going 3 div peak signal.

b. From 16 percent to 98 percent of the leading and trailing edge of a negative going 3 div peak signal.

3.5.5.6.2 Internal trigger sensitivity. Stable sweep operation shall be obtained from the following signals:

a. Low frequency. A sine wave having 1 div peak to peak (pp) vertical deflection from 2 Hz to 1 MHz.

b. High frequency. A sine wave having 1 div pp vertical deflection from 1 MHz to 4 MHz, increasing to not more than 2.5 div at 15 MHz.

c. Pulse. A pulse having a 25 nsec rise time, 25 nsec duration with a pulse repetition frequency from 1 to 300 pulses per second (pps) and ±1 div peak vertical deflection.

3.5.5.6.3 External trigger sensitivity. Stable sweep operation shall be obtained from the following input signals:

a. Low frequency, AC and DC coupled.

(1) AC coupled. A sine wave of 1 volt pp from 50 Hz to 5 MHz.

(2) DC coupled. A sine wave of 1 volt pp from 1 Hz to 5 MHz.

b. High frequency, AC and DC coupled. A sine wave of 1 volt pp from 5 MHz to 15 MHz.

c. Maximum input trigger level. The instrument shall be capable of triggering on signals of 50 volts pp.

d. Input impedance. The external trigger input impedance shall be not less than 100 kilohms, paralleled by not more than 35 pf.

3.5.5.6.4 Automatic.

a. Internal. In this mode, a signal having an amplitude of 1 volt pp shall provide a stable display from 50 Hz to 15 MHz. Provisions shall be made for free running the sweep in the absence of an input signal.

b. External. In this mode, a signal having an amplitude of 1.2 volts pp shall provide a stable display from 50 Hz to 15 MHz.

3.5.5.6.5 AC low frequency reject. The AC low frequency reject mode shall be available in both internal and external triggering modes. When in the AC low frequency reject mode, 25 kHz shall be attenuated by at least 3 db.

3.5.6 Voltage calibrator. A square wave voltage shall be provided on the front panel through a tip jack or type BNC female connector. The amplitude of the output shall be accurate to within ±3 percent of indicated value. There shall be no noticeable overshoot, ringing, or droop on the square wave. The square wave shall be symmetrical to within ±5 percent.

3.5.7 Accessories.

3.5.7.1 Voltage divider probes. Two input probes shall be provided with the instrument.

3.5.7.1.1 Electrical characteristics.

a. Maximum input voltage, 500 volts DC.

b. Attenuation factor, 10:1.

c. Impedance. Nine megohms ±1 percent, paralleled by not more than 15 pf. The capacitance shall be variable to compensate for slight input capacitance differences in instruments.

3.5.7.1.2 Mechanical characteristics.

a. Probe tips. A long tip, short tip, and pincer tip shall be provided with each probe.

b. Ground lead. A ground lead, consisting of an insulated alligator clip and insulated lead, shall be provided with each probe. The ground lead shall be at least 6 inches long and removable from the probe body.

c. Cable. A shielded cable shall be attached to the probe and terminated in a type BNC male connector. The cable shall be at least 42 inches long and flexible enough to prevent breaking during normal usage.

d. Overall performance. The probe shall not degrade any of the performance requirements specified in 3.5.3 through 3.5.10.

3.5.7.2 Accessory storage cover. The instrument shall be provided with an accessory storage cover. The cover shall provide storage space for the voltage divider probes. The cover shall have clips, bands, or other suitable means for holding the accessories firmly in place.

3.5.7.3 Time totalizing meter. The instrument shall incorporate a time totalizing meter in accordance with MS 17321-4 and a flange in accordance with MS 3345-1 on the front or rear panel as an integral part of the instrument.

3.6 Electrical requirements.

3.6.1 Warm-up. The instrument's warm up time, at temperatures down to 0^{o} Centigrade (C), shall not exceed 20 minutes.

3.6.2 Power. The instrument shall be capable of operating within specifications with an input root mean square (rms) voltage of 115 and 230 volts, $\pm$ 10 percent. The instrument shall accept and operate satisfactorily on any line voltage frequency of 50, 60, or 400 Hz $\pm$5 percent.

3.6.2.1 Power selection. A switching device, capable of selecting the desired input line voltage of 115 or 230 volts, shall be accessible from the front or rear panel of the instrument. The device shall have a positive locking action to prevent accidental selection of the improper line voltage. The 115 and 230 volt positions shall be clearly marked. The instrument shall be delivered with the power selection device in the 115 volt position and a proper fuse(s) installed. If a different size fuse is required for 230 volt operation, the proper fuse(s) shall be attached to the caution tag. The following caution tag shall be attached to the instrument:

"CAUTION: THIS INSTRUMENT IS CONNECTED FOR 115 VOLT OPERATION"

3.6.3 Power disconnect. A switching device and fuse(s) shall be installed in series with the power input to the instrument. The fuses shall be externally accessible.

3.6.4 Power cable. A power input cable, either fixed or detachable, shall be provided. The power cable shall be fitted at one end with the Electronic Industries Association recommended grounding type parallel blade, 3 wire male connector. Adapters shall be provided to convert from the grounding 3 wire connector to the nongrounding connector for 115 volt operation. The length of the power cable with connector shall be at least 68 inches, external to the instrument.

3.7 Mechanical requirements.

3.7.1 Dimensions. The girth (face perimeter) plus the depth of the instrument shall be not greater than 78 inches.

3.7.2 Weight. The unpacked weight of the instrument shall be not greater than 35 pounds.

3.7.2.1 Portability. The instrument shall be fitted with a carrying handle(s), capable of supporting the weight as specified in 3.7.2. The location of the handle(s) shall be such that the above weight is evenly distributed for easy handling.

3.7.3 Cooling. The instrument shall not overheat while operating 24 hours in an ambient temperature of 25°C, when restricted on all sides and the rear with a clearance of 2 inches. This may require an internal electromechanical device, such as a fan or blower. If such a device is required, (a) through (f) shall apply.

a. The device shall be an integral, permanently attached part of the unit.

b. The device shall not require an additional power input source.

c. The air inlet shall be filtered against dust and the filter shall be easily accessible and removable for cleaning.

d. The device shall not interfere with any operation of the instrument through noise, electrical interference, or vibration.

e. A thermal switch or relay shall be provided which will interrupt line power to the unit when the internal temperature rises to the degree of possible damage to the instrument.

f. Commutated or brush type motors shall not be used.

3.7.4 Markings.

3.7.4.1 Panel. Panel markings shall be stamped, etched, or engraved and shall be filled with a permanent material which contrasts with the color of the instrument's panel. Silk screening may be used if the markings are covered by a permanently attached clear material (plastic) that is at least 0.05 inches thick. The material used shall be capable of withstanding the environmental requirements specified herein.

3.7.4.2 Dials and switches. Dial and switch markings shall be stamped, etched, or engraved and shall be filled with a permanent material which contrasts with the color of the instrument's dials and switches.

3.7.4.3 Identification of product. Equipment, assemblies, and parts shall be marked for identification in accordance with MIL-STD-130.

3.7.5 Workmanship.

3.7.5.1 General. The instrument shall be capable of meeting the design and construction requirements specified in 3.2, and shall be free from any damage or defect that could result in failure to comply with the requirements of this description.

3.7.5.2 Detail. The workmanship shall be such that no evidence of any physical damage or defect shall be evident upon examination of assembly and fit, materials, parts, freedom from binding, wiring assembly (lacing) and insulation, soldering, impregnation of coils, markings and identification of parts, accessibility to interchangeable parts, freedom of parts from burrs and sharp edges, finishes, and external alignment of component parts and assemblies.

3.7.5.3 Connectors. Unless otherwise specified herein, all input and output connectors shall be type BNC female.

3.7.5.4 Controls. Operating and adjustment controls, both internal and external shall be readily accessible, suitably arranged, and of such size and construction to permit convenience and ease of operation under all service conditions. Unless otherwise specified, operating controls shall be located on the front panel of the instrument. Selector switches shall have positive detent action and shall be aligned properly with their markings.

3.8 Environmental requirements. The instrument shall show no evidence of physical damage or circuitry failure and shall maintain the accuracies specified in 3.5, after being subjected to the following environmental conditions:

a. Temperature, operating - 0°C to plus 55°C.

b. Temperature, nonoperating - Minus 54°C to plus 75°C.

c. Vibration - Total displacement of 0.02 inches from 25 to 55 Hz and 0.04 inches from 10 to 25 Hz for 30 minutes at each of the instrument's reasonant frequencies.

d. Shock - Dropping the instrument on a hardwood table top after each bottom horizontal edge of the top, bottom, and two sides is elevated 4 inches or when the horizontal axis forms an angle of 45 degrees with the table top, for a total of 16 drops.

e. Altitude, operating - 0 to 10,000 feet.

f. Altitude, nonoperating - 0 to 50,000 feet.

g. Humidity - 0 to 90 percent.

3.8.1 Environmental test sequence. Before performing the environmental tests, the instruments shall have been subjected to and passed all electrical and functional tests specified in the approved first article test procedures. At the completion of the environmental tests specified in 4.1.3, the instruments shall be subjected to the electrical and functional tests specified in the approved first article test procedures.

3.9 Reliability. Instruments furnished under this purchase description shall be capable of passing a production reliability acceptance test in accordance with the provisions of MIL-STD-781, Test Plan II, with a minimum acceptable Mean Time Between Failure (MTBF θ_1), computed by dividing the contractor's bid MTBF (θ_0) by the discrimination ratio for Test Plan II (1.5), with a specified MTBF (θ_0) of not less than 2250 hours. To be responsive to the Government's minimum reliability requirements, the value of θ_1 computed must be not less than 1500 hours. Proposals which anticipate providing a θ_1 greater than 1500 hours will be considered responsive to the extent that the rationale submitted in support thereof provides clear and compelling evidence of the attainability of the value proposed. The ability of a contractor to furnish instruments capable of passing the above test with a θ_1 greater than 1500 hours will serve to reduce the life cycle recurring costs. This θ_1, greater than 1500 hours, shall be verified in accordance with the provisions of MIL-STD-781, Test Plan II. The maximum bid MTBF (θ_0) shall not exceed 4500 hours.

4. TEST PROVISIONS

4.1 First article tests. First articles will be tested by the Government to ascertain the capability of the proposed instruments to meet the performance requirements described herein, and to further ascertain that the proposed instruments are capable of achieving the minimum acceptable reliability requirements of the Government. First article testing shall be accomplished in accordance with the approved first article test procedures, and

MIL-STD-781 Test Plan VII, utilizing a value of θ_1 = 1500 hours. The above test shall, in no way, address the attainability of the value of θ_1, proposed by the contractor for production items.

4.1.1 First article test procedures. The contractor shall develop detailed test procedures for testing the first articles to the performance, electrical, and mechanical requirements specified in Section 3. The test procedures shall reference the test method to the applicable requirement being tested. The test procedures shall be sequenced in the order that the contractor intends them to be performed. These test procedures shall be submitted to SANETE 30 days prior to shipment of the first article. The procedures will be utilized during conduct of the first article test. The Government reserves the right to amend the test procedures if during first article testing it becomes apparent that the procedures are not adequate. The contractor will be advised of any changes deemed necessary, and will be offered the opportunity to comment. Failure to comment within 10 days from the date receipt of such changes shall constitute agreement. In the event that the contractor does not agree with the proposed changes, the contractor shall submit revisions to the original procedures, which will overcome the deficiencies. The Government reserves the final authority to ascertain the adequacy of the test procedures, and such final changes as may be made thereto shall in no way affect the liability of the contractor to provide instruments capable of passing the required tests.

4.1.2 Deleted

4.1.3 Environmental tests. These tests will be performed on all first article samples and on the production samples tested by the Government.

4.1.3.1 Temperature test, nonoperating.

4.1.3.1.1 Low temperature test. Place the instrument in a temperature test chamber and reduce the temperature of the chamber to minus 54°C. Maintain this temperature for four hours. Return the test chamber and instrument to room temperature in 60 minutes. Remove the instrument from the test chamber and immediately perform the test specified for requirement 3.5.3.3. The instrument shall operate within the specified tolerances and there shall be no indication of failure as a result of the low temperature.

4.1.3.1.2 High Temperature test. Place the instrument in a temperature test chamber and evaluate the temperature of the test chamber to plus 75°C. Maintain this temperature for four hours.

Return the test chamber and instrument to room temperature in 60 minutes. Remove the instrument from the test chamber and immediately perform the test specified for requirement 3.5.3.3. The instrument shall operate within the specified tolerances and there shall be no indication of failure as a result of the high temperature.

4.1.3.2 Vibration and shock.

4.1.3.2.1 Vibration test. The instrument shall be rigidly attached, in the normal operating position, to a vibration testing mechanism. The reasonant frequencies of the instrument shall be determined by varying the frequency of applied vibration slowly through the range specified in 3.8c at reduced amplitudes. Individual reasonance searches shall be conducted with the vibration applied along each of the three mutually perpendicular axis of the instrument. The instrument shall then be subjected to a total displacement of 0.02 inches from 25 to 55 Hz and 0.04 inches from 10 to 25 Hz for 30 minutes at each of the instrument's resonant frequencies, and at 10 Hz and 55 Hz for 15 minutes at each frequency. At the completion of this test, perform the test specified for requirement 3.5.3.3. The instrument shall operate within the specified tolerances and there shall be no evidence of physical damage or circuitry failure as a result of vibration.

4.1.3.2.2 Shock. The instrument shall be subjected to the following shock test on a hardwood table top. Using one edge of the instrument as a pivot, tilt the instrument until the horizontal axis of the assembly forms an angle of 45 degrees with the table top or until the elevated edge is four inches above the table top, whichever occurs first. Allow the instrument to drop freely to the horizontal. Repeat this procedure, using the other edges of the same horizontal face and the other three sides, excluding the front and rear, for a total of 16 drops. At the completion of this test, perform the test specified for requirement 3.5.3.3. The instrument shall operate within the specified tolerances and there shall be no evidence of physical damage or circuitry failure as a result of this test.

4.1.3.3 Temperature, altitude, and humidity, operating.

4.1.3.3.1 Low temperature and altitude tests. Place the instrument in a test chamber and make the necessary connections for external measurements. Adjust the chamber conditions to 10,000 feet altitude and 0°C. Maintain this temperature and altitude for two hours. Apply power to the instrument and allow 20 minutes for warm up. Perform the test specified for requirement 3.5.3.3.

The instrument shall operate within the specified tolerances and there shall be no indication of failure as a result of this test. Return the test chamber and instrument to room temperature.

4.1.3.3.2 High temperature and humidity tests. Place the instrument in a test chamber and make the necessary connections for external measurements. Adjust the chamber conditions to 90 percent relative humidity and plus 55°C. Maintain this temperature and humidity for 20 hours. Apply power to the instrument and allow 20 minutes for warm up. Perform the test specified for requirement 3.5.3. The instrument shall operate within the specified tolerances and there shall be no indication of failure as a result of this test. Return the test chamber and instrument to room temperature.

4.1.3.4 Altitude, nonoperating. Place the instrument in a test chamber. Adjust the chamber conditions to 50,000 feet altitude. Maintain this altitude for two hours. Return the test chamber and instrument to normal ground and perform the test specified for requirement 3.5.3.3. The instrument shall operate within the specified tolerances and there shall be no indication of failure as a result of this test.

4.1.4 Production reliability test procedures. Upon final approval by SANETE, the first article test procedures shall be used as production test procedures; however, the statistical test plan for production sample testing shall be different than first article testing and shall be as described in 3.9 with the objective of validating the contractor's claimed reliability and quality control on reliability.

4.2 Production testing.

4.2.1 Production test procedures. The contractor shall test each instrument to the requirements specified in 3.5.2.2, 3.5.3.3, 3.5.3.4, 3.5.3.5, 3.5.4.1, 3.5.5.1, 3.5.5.3, 3.5.5.4, 3.5.5.5, 3.5.5.6.1, 3.5.5.6.2, 3.5.5.6.3, 3.5.5.6.4, 3.5.5.6.5, 3.5.6, and 3.6.2. The tests shall be performed in accordance with the applicable procedures in the approved first article test procedures.

4.2.1.1 When one instrument from a production lot fails to meet requirement in 4.2.1, instruments on hand or later produced shall not be accepted until the cause of failure (see 3.2.4) is determined and corrected. The contractor shall explain fully to the Government representative the cause of failure and the action taken to preclude recurrence.

4.2.2 Production sampling plan and reliability tests. Two instruments from each consecutive production of 25 instruments, for a total of not less than 10 instruments, produced on a contract or order shall be submitted to SAAMA (see address for first article) for production testing. These instruments shall be subjected to the entire approved first article test procedures referenced in 4.1 and in accordance with the statistical test plan referenced in 3.9.

4.2.2.1 Failures during test. If a failure occurs, the contractor shall furnish by written notice, the cause(s) of failure and correction(s) to be made. The contractor shall supply parts for the repair(s) and the Government shall repair the instrument under supervision of the contractor. The reliability testing of the instrument shall be continued after the repair.

4.2.2.2 Minimum acceptable MTBF reliability test. The complete acceptance of the production instruments is contingent upon the completion of the reliability testing to attain θ_1 of 1500 hours. This test shall be performed in accordance with MIL-STD-781, Test Plan II. Items shall be shipped after completing the tests in 4.2.1 and prior to the results of this reliability test. In the event that the production samples fail to pass this reliability test for θ_1 shipment on all instruments will be stopped and the contractor shall furnish, by written notice, the cause(s) of failure and correction(s) to be made. The correction(s) shall be made on the samples under test, and the complete reliability test shall again be performed. If the samples pass this reliability test, then all items on hand and items shipped shall be reworked by the contractor. The shipping of the items to and from the contractor for this rework shall be at the expense of the government.

4.2.2.3 Bid MTBF reliability test. This test shall be run only if the contractor bids a θ_1 greater than 1500 hours. This test shall be a continuation of the test in 4.2.2.2. The complete data recorded in 4.2.2.2 shall be used to start testing and determine accept or reject criteria in accordance with MIL-STD-781, Test Plan II. Once this test is started, it must be continued to either the accept or reject criteria, unless terminated by mutual agreement between the contractor and the Government. In the event that the samples do not meet the contractor's bid θ_1, the Government will terminate testing and accept the point estimate achieved during testing for purposes of calculating final payment price. In determining this point estimate the total number of failures will be divided into the total test time at termination of this test. The point estimate must be greater than 1500 hours or the item shall be reworked and retested as in paragraph 4.2.2.2.

4.2.3 Input voltage cycling. The input voltage to the samples under test shall be varied in accordance with the following schedule: 125 volts for the first 24-hour cycle, 115 volts for the second 24-hour cycle, and 105 volts for the last 24-hour cycle. These 24-hour cycles shall be repeated until the accept-reject criteria in 3.9 is met. Continuous testing is not mandatory; these tests may be run in 8-hour intervals with the input voltages controlled to within ±2 percent. Concurrent testing of samples is encouraged.

4.2.4 Test intervals. The individual test for 3.5.3.3 shall be run at 24-hour intervals of operation at the input voltage conditions as specified in 4.2.3. This test shall be repeated as many times as necessary to reach a decision in accordance with 3.9. In the event that a sample failure is detected in the 24-hour interval test, and the exact time of failure cannot be ascertained, the sample shall be credited with 12 hours of successful operation for that particular 24-hour interval or 1/2 the total time of the interval. The operational mode to be used during operating periods, when the instrument is not undergoing specification checks, will be the test specified for 3.5.3.3. No calibration or adjustments shall be made once the test is started, beyond those allowed under individual test procedures. Operating time accumulated during the specification checks may be included as part of the total operating time.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging, packing, and marking. The equipment, accessories, and technical publications shall be preserved, packaged, packed and marked in accordance with MIL-E-17555, Level A, B, or C (See 6.2)

6. NOTES

6.1 Intended use. The instruments are intended for bench use in precision laboratory, field, shop and depot maintenance applications.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this purchase description.

b. Type CRT phosphor required (see 3.5.2.1).

c. Selection of applicable level of preservation, packaging, and packing.

CASE 4

TACHOMETER-GENERATORS

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CASE 4

TACHOMETER-GENERATORS

This Case is an actual procurement made by the Air Force Logistics Command. The procurement action was made by the Oklahoma City Air Materiel Area under RFP F 34601-69-R-1286 (PR OC-9-42693).

This Case is presented without a proposal analysis or discussion since examples have been included in the procurement documents which are self-explanatory.

Only those portions of the RFP which are germane to life cycle cost evaluation and award are included, together with a description of the items procured and a statement of the reliability requirements and testing procedures (Appendix A).

The primary points to note are that the life cycle cost elements considered in this Case are:

1. ITEM LIFE
2. ACQUISITION AND INSTALLATION COSTS

Although the government pays the transportation costs, they have not been included.

The item is a non-reparable and the cost criterion is, therefore, cost per operating unit.

Note that, in conformance with USAF practice in the actual procurement, the words "bid" and "bidder" are used to mean proposals and those who submit them.

A penalty clause for failure to meet stated service life is included. The penalty provision in this Case is not a sharing arrangement. The rebate is calculated so that the Government will experience an actual Unit Operating Cost (UOC) no higher than the bid UOC. If actual service life, θ, is less than bid service life, θ_1, then the amount of the rebate to the Government equals

$$(\text{bid UP} + \text{LOG}) - (\text{bid UP} + \text{LOG}) \frac{\theta}{\theta_1}$$

or

$$(1 - \frac{\theta}{\theta_1}) \quad (\text{bid UP} + \text{LOG}).$$

Pertinent provisions of the RFP are:

SPECIAL NOTICE TO OFFERORS:

This is a life cycle cost Request for Proposal implementing the Armed Services Procurement Act of 1947 which states in part "Award shall be made to the responsible bidder whose bid will be most advantageous to the United States price and other factors considered." Life Cycle Costing method of procurement allows the Air Force to evaluate contractor's proposals for equipment and material not just for lowest initial price but for lowest total life cycle cost and incorporates penalties for marginal performance.

PART I. STATEMENT OF WORK

A. SUPPLIES AND SERVICES TO BE FURNISHED

The Contractor shall furnish to the Air Force, in accordance with the provisions of this schedule and Exhibit A (Special Conditions) and Exhibit B (Statement of Work), copies of which are attached hereto and incorporated herein, the following items:

ITEM	DESCRIPTION	QTY	UNIT PRICE	TOTAL AMOUNT
1	Generators, Tachometer FSN 6620-769-6984 P/N MS25038-1 Offeror's proposal shall include in addition to prices, a statement of the items' mean time between failure (MTBF) (Service life) along with the rationale supporting the MTBF as defined and described under evaluation provisions contained herein. Do not refer to price on Data supporting Engineering/ Technical aspects to be evaluated.	2587ea	$____	$____

ITEM	DESCRIPTION	QUANTITY	AMOUNT
2	First Article testing in accordance with requirements of Exhibit "B" hereof. Prices quoted for First Article Testing shall not include the cost of the three (3) units to be used in the tests. If the offeror does not insert a price for First Article Testing or enters the words "No Charge" or similar language, the price for this item will be considered as included in the price of Item 1.	1 Lot	$_____
3	Data in accordance with the provisions hereof and Exhibit "C" (DD Form 1423) attached hereto and made a part hereof.		
	TOTAL PRICE OF DATA ITEMS		$_____
4	Reliability Testing in accordance with Exhibit "B" hereof.	1 Lot	$_____

* * * *

PART II. TIME OF DELIVERY

A. Within 60 days after receipt of written notice of award or a fully executed contract, whichever is earlier, the contractor shall notify the Contracting Officer of his readiness to accomplish First Article Testing and will proceed with the test upon instruction from the Contracting Officer.

B. Contract Item 1 shall be delivered to the Government in accordance with the following schedule:

SEP 1969	OCT 1969	NOV 1969	DEC 1969
700	700	700	757

* * * *

SPECIAL CONDITIONS SECTION

1. General. This is a life cycle cost Request for Proposal. Life Cycle Costing (LCC) is a method of procurement which facilitates the Air Force award of contracts on the basis of lowest life cycle cost in accordance with the spirit and intent of the Armed Services Procurement Act of 1947 rather than on the basis of lowest initial price. This program incorporates:

a. Bid evaluation procedures which will result in contract award on the basis of minimum cost per unit of service life.

b. A requirement for contractor reliability acceptance testing.

c. Penalty provisions for failure to deliver production hardware providing a MTBF greater than or equal to the value of MTBF upon which bid evaluation and contract award was predicated.

2. Basis for Award. The contract shall be awarded to that offeror whose hardware will provide the minimum operating cost per unit of service life as calculated in accordance with the formula $UOC = \frac{UP + LOG}{SL}$, where UOC is the unit operating cost, UP is the bid unit price, LOG is a constant cost of $21.75 for such logistics actions as have been explicitly associated with an operating activity obtaining and installing the tachometer-generator and SL is the service life which the offeror bids and will subsequently demonstrate as the value θ_1 in the post-award reliability acceptance test.

3. Service Life Rationale. A failure is as defined in the Statement of Work accompanying and made a part of this solicitation. The occurrence of a failure on an operating item shall constitute the ending of the useful service life of that item. Thus, MTBF and mean service life are synonymous for the purposes of this procurement because the Air Force manages the tachometer-generator as a non-recoverable item, notwithstanding the requirements set forth in MIL-G-5413D, paragraph 3.4.1. Each offeror responding to this solicitation shall provide as a separate element of his response a complete rationale

supporting the attainability of his proposed Service Life (θ_1) in a controlled test utilizing the environmental profile and statistical test plan stipulated in the Statement of Work accompanying this solicitation. There are no limitations imposed upon the form and content of this rationale; however, each potential offeror is herewith advised that it is incumbent upon each offeror to present a convincing case in support of his proposed service life (θ_1). The proposed service life (θ_1) and substantiating rationale submitted by each offeror in response to this solicitation shall be reviewed by a technical review board comprised of engineering and technical personnel of the government and chaired by a qualified graduate engineer. This technical review board shall ascertain the relative feasibility of attaining an "Accept" decision in a Reliability Acceptance Test as described in the Statement of Work accompanying this solicitation. Each offeror is encouraged to submit a supporting rationale that offers full and convincing evidence of the attainability of his proposed service life (θ_1). However, in those situations where the Government deems it appropriate, offerors may be asked to provide additional information or clarification prior to exercising any of the prerogatives set forth below. Upon review of the proposed service life (θ_1) and the supporting evidence of its reasonableness, the government reserves the right to invoke any of the following options with regard to any offeror who is otherwise determined to be responsive to all solicitation requirements exclusive of proposed service life (θ_1):

a. Based solely upon the judgment of the technical review board, the government reserves the right to conclude that the proposed service life (θ_1) is not reasonable for the hardware proposed, considering the rationale submitted in support of the proposed service life (θ_1). In the event that the government arrives at the above conclusion, the government shall declare the offeror in question nonresponsive to the provisions of this solicitation and shall notify the offeror in writing stating the reason(s) for such determination.

b. Based solely upon the judgment of the technical review board, the government reserves the right to conclude that the proposed service life of the offeror is reasonable and attainable for the hardware proposed considering the rationale submitted in support of the proposed service life (θ_1). Such a conclusion may be arrived at irrespective of how ordinary or extraordinary the proposed service life (θ_1) may appear in

comparison to the service life observed or alleged to be available from other hardware having the same form, fit, and function.

4. Penalty Provisions. The contractor selected agrees to accomplish a first article reliability test and a production reliability test as set forth in the Statement of Work attached hereto and made a part thereof. In the event that an accept decision is reached during the first article reliability test of said Statement of Work or in the event that a reject decision is reached and the value of the unbiased estimate of service life (θ) computed in accordance with paragraph 5.2 of said Statement of Work is equal to or greater than the value of θ_1 used as the basis for bid evaluation, the contractor shall initially be paid the unit price bid for each production item delivered; however, this initial unit price shall be subject to the penalty provisions set forth in this paragraph for failure to demonstrate a value of at least θ_1 during the production reliability test phase. In the event that a reject decision is reached during the first article reliability test of said Statement of Work and the value of θ computed in accordance with paragraph 5.2 of said Statement of Work is greater than one-thousand (1,000) hours and less than the value of θ_1 used as a basis for bid evaluation, the contractor shall initially be paid a unit price less than the price originally bid for each item delivered prior to the completion of the production reliability test. Following the completion of the production reliability test, reimbursement shall be made or additional penalties shall be imposed based upon the results of this reliability test. The penalty to be initially deducted shall be:

$$\left(1 - \frac{\theta}{\theta_1}\right) \quad \text{(Unit Bid Price + \$21.75)}$$

where θ and θ_1 are as defined in the Statement of Work attached hereto. In the event that the value of θ calculated in accordance with paragraph 5.2 of said Statement of Work is less than one-thousand (1,000) hours during the first article reliability test, the government reserves the right to terminate the contract for default at the discretion of the contracting officer. In the event that an accept decision is reached during the production reliability test of said Statement of Work, or in the event a reject decision is reached and the value of θ as computed in accordance with paragraph 5.2 of said Statement of Work is equal to or greater than the value of θ_1 used as the basis for bid evaluation, the contractor shall be paid the unit price

originally bid for each production item delivered, irrespective of initial penalties imposed on the basis of first article reliability test results. In the event that a reject decision is reached during the production reliability test of said Statement of Work and the value of θ computed in accordance with Paragraph 5.2 of said Statement of Work is less than the value of θ, used as the basis for bid evaluation, the contractor shall be paid a unit price less than the price originally bid for all items delivered to the government under this contract. The penalty to be deducted from the original unit price shall be:

$$\left(1 - \frac{\theta}{\theta_1}\right) \quad \text{(Unit Bid Price + \$21.75)}$$

where θ and θ_1 are as defined in the Statement of Work attached hereto. The total contract penalty shall be determined by multiplying the unit price determined as above, by the number of units ordered.

5. Production Items. The attention of each offeror is specifically invited to the fact that units utilized in first article or production reliability acceptance testing shall not be considered as deliverable production items except to the extent set forth in paragraph 3.2.1.5 of the Statement of Work attached hereto. Accordingly, the offeror's unit bid price should include ammortization of all the costs of undeliverable units.

6. Illustration of Bid Evaluation.

Offeror Identification	Unit Price	Proposed Mean Service Life (θ_1)	Unit Operating Cost
A	\$30	1,000 Hours	\$ .0518
B	\$40	1,200 Hours	\$ .0515
C	\$50	1,100 Hours	\$ .0652
D	\$70	2,100 Hours	\$ .0437

a. Evaluation of Bidder A = $\frac{\$30 + \$21.75}{1,000}$ = \$ .0518

b. Evaluation of Bidder B = $\frac{\$40 + \$21.75}{1,200}$ = \$ .0515

c. Evaluation of Bidder C = $\frac{\$50 + \$21.75}{1,100}$ = \$ .0652

d. Evaluation of Bidder D = $\frac{\$70 + \$21.75}{2,100}$ = $ .0437

e. In this example, the unit proposed by Bidder D will serve to minimize cost per unit of operating time, thus, subject to the contingency that the value of θ_1 proposed by Bidder D is found reasonable by the Technical Review Board and form, fit and function is deemed to be satisfactory, Bidder D would be declared the low responsive bidder, price and other factors considered.

7. Illustration of Penalty Application. Based upon award of a contract and successful completion of First Article Testing, Bidder D would go into production and accomplish a Production Reliability Acceptance Test in accordance with the provisions of MIL-STD-781, Test Plan II, utilizing a value of θ_1 = 2,100 hours and θ_0 = (2,100) (1.5) = 3,150 hours. Upon completion of testing, if the value of θ is computed to be something less than 2,100 hours the equation would be employed to ascertain the value of the penalty. Penalty equals $(1 - \frac{\theta}{\theta_1})$ (U.P. + LOG). Presuming that the test is failed and a value of θ = 1,900 hours is computed in accordance with the provisions of paragraph 5.2 of the Statement of Work. Thus, the penalty per delivered production unit would be $(1 - \frac{1,900}{2,100})$ ($91.75) = $8.74. Therefore, the final adjusted price paid the contractor per item would be ($70.00 - $8.74) = $61.26.

8. The Reliability Test Reports required by MIL-STD-781 will be furnished in accordance with the provisions of MIL-STD-781.

9. Delivery Relationship to Reliability Acceptance Testing. Delivery of production units to the government shall be in accordance with the delivery schedule set forth elsewhere in this solicitation, but is not conditioned upon passing the production Reliability Acceptance Test described in the Statement of Work. In the event that the production Reliability Acceptance Test is not completed prior to delivery of all or part of the production quantity of units, the delivered units shall be billed to the government at the Bid Unit Price subject to the penalties resulting from results of the first article testing. Subsequent to completion of the Reliability Acceptance Test, any refund that may be in order by virtue of application of the Penalty Clause herein described shall be computed by the Contracting Officer. The Contractor shall then be notified by the Contracting Officer in writing as to the amount and method of payment. The Contractor shall take the action indicated within 30 days after receipt of the Contracting Officer's refund notification.

10. Price Information. No information relating the price the offeror proposes to charge the government shall be included in technical documentation to be reviewed by the government's Technical Review Board. This will assure that ultimate degree of objectivity is given to the evaluation of technical considerations.

CASE 4

APPENDIX A

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STATEMENT OF WORK
GENERATORS, TACHOMETER, FOUR-POLE
(MS 25038-1)

1. SCOPE. This is a statement for the requirements, testing and evaluation of a four-pole tachometer-generator to be designed and manufactured for competitive procurement under Life Cycle Costing (LCC) concepts.

2. APPLICABLE DOCUMENTS:

2.1 The following documents, of the issue in effect on date of invitation for bids, form a part of this specification to the extent specified herein:

SPECIFICATIONS

Military

MIL-G-5413D Generators, Tachometer, Four-Pole

Standards

MIL-STD-781 Reliability Tests: Exponential Distribution

3. REQUIREMENTS: The tachometer-generator shall be designed to meet all of the requirements set forth in MIL-G-5413D, dated 30 June 1966, including all amendments in effect on date of contract except as specified herein.

3.1 Design for Reliability. In accordance with MIL-G-5413D, paragraph 3.8.1.2, the tachometer-generator, MS 25038-1, proposed by any offeror must be capable of providing a minimum acceptable MTBF of 1,000 hours. Consistent with the above, the hardware furnished shall be capable of meeting the requirements of a production reliability acceptance test in accordance with the provisions of MIL-STD-781, Test Plan II, TEST LEVEL G, with a minimum acceptable MTBF (θ_1) of not less than 1,000 hours. The value of θ_1 proposed by the offeror must be equal to or greater than 1,000 hours; however,

proposals which anticipate providing a θ_1 greater than 1,000 hours will be considered responsive to the extent that the rationale submitted in support thereof provides clear and compelling evidence of the attainability of the value proposed. The ability of an offeror to furnish tachometers-generators capable of satisfying the requirements of the above test with a θ_1 greater than 1,000 hours will serve to reduce the cost per unit of service life for bid evaluation purposes.

3.2 Test Provisions

3.2.1 First Article Tests. In lieu of qualification testing as specified in MIL-G-5413D, first article testing shall be accomplished by the offeror to ascertain the capability of the proposed tachometer-generator to meet the performance requirements of MIL-G-5413D and to further ascertain that the proposed equipments are capable of achieving the minimum acceptable reliability requirements of the Government. First article testing shall be accomplished in accordance with the quality conformance inspection requirements of MIL-G-5413D, paragraph 4.4, with the exception that sampling Plan B shall be performed and reliability test Plan VII, MIL-STD-781, shall be used in lieu of the reliability requirements of MIL-G-5413D. Because the endurance test of paragraph 4.6.14, MIL-G-5413D, is essentially accomplished under the requirements of the first article reliability test, the offeror shall not be required to perform this test under sampling Plan B, MIL-G-5413D. The test details associated with the performance of the above reliability test shall be as specified within this document in lieu of the test details specified in MIL-G-5413D.

3.2.1.1 First Article Test Procedures. The offeror shall develop detailed test procedures for testing the first article to the performance, electrical and mechanical requirements of MIL-G-5413D. The test procedures shall reference the test method to the applicable requirement being tested. The test procedures shall be sequenced in the order that the offeror intends them to be performed. These test procedures shall be submitted for approval to OCAMA/OCNEC at least 30 days prior to the planned starting date of first article testing. The approved procedures shall be utilized during the performance of the first article test. The Government reserves

the right to amend the offeror's test procedures, if it is determined that these procedures do not satisfy the test requirements of MIL-G-5413D. The offeror will be advised of any changes deemed necessary to his proposed procedures and will be offered the opportunity to comment. Failure to comment within 10 days from the date of receipt of such changes shall constitute agreement to these changes. In the event that the offeror does not agree with the Government's proposed changes, the offeror shall submit revisions to the original test procedures which will overcome the deficiencies. The Government reserves the final authority to ascertain the adequacy of the test procedures and such final changes as shall be made thereto shall in no way affect the liability of the offeror to provide equipments capable of meeting the requirements of the specified tests.

3.2.1.2 Reliability Test Procedures. The offeror shall develop reliability test procedures in accordance with the provisions of paragraph 3.2.1.1, with the exception that these procedures shall contain provisions for accomplishing the reliability test requirements specified in paragraph 4 of this document. Except as otherwise specified by the detailed requirements of this document or as otherwise specified by the procurement activity upon completion of the first article testing, the test procedures developed in accordance with the requirements of this paragraph shall be used during the performance of the production reliability test phase.

3.2.1.3 First Article. The first articles shall consist of twenty-one (21) MS 25038-1 tachometer-generators. Three (3) of these units shall be used in demonstration of the test requirements of sampling Plan B of the quality conformance inspection provisions of MIL-G-5413D, as amended by this document. Eighteen (18) of these units shall be made available for performing the first article reliability test requirements set forth in paragraph 4 of this document. All of the first articles shall be subjected to the Individual Inspection requirements of MIL-G-5413D prior to start of the reliability test.

3.2.1.4 Disposition of Samples Upon Completion of Tests. Samples submitted as first articles shall be disposed of as provided in paragraph 4.4.3.3.5, MIL-G-5413D.

3.3 Production Testing. The offeror shall test each tachometer-generator in accordance with the requirements of

MIL-G-5413D with the exception that the reliability sampling plan of this document shall be performed in lieu of the reliability sampling plan specified in MIL-G-5413D.

3.3.1 Production Sampling Plan for Reliability Testing. Three (3) tachometer-generators shall be selected at random from the first one-hundred (100) units produced after the start of production and one (1) unit shall be selected from each subsequent lot of one-hundred (100) units and subjected to the production reliability test specified in paragraph 4 of this document until such time as a maximum of fifteen (15) units are under test. Additional units shall be selected at the rate of one (1) unit from each subsequent lot of one-hundred (100) units and shall be used for the purpose of replacing test units which fail.

4. RELIABILITY TEST DETAIL REQUIREMENTS: Unless otherwise specified below, the requirements and conditions specified in MIL-STD-781 shall apply to the performance of the reliability tests specified in this document.

4.1 Conditions Preceding the Reliability Tests. The provisions of MIL-STD-781, paragraph 5.1, shall apply except as follows:

4.1.1 Failure Rate Prediction. The contractor shall predict a failure rate as specified in MIL-STD-781, paragraph 5.1.1. This prediction, along with the rationale used to arrive at the value predicted, shall be included in the initial bid proposal in accordance with paragraph 3.1 of this document.

4.1.2 Design and Performance Tests. The contractor shall demonstrate conformance to the requirements of sampling Plan B, MIL-G-5413D, prior to start of the first article reliability test. All equipments submitted for reliability testing shall be subjected to the individual inspection requirements of MIL-G-5413D prior to performance of reliability testing.

4.1.3 Detail Reliability Test Procedures. The contractor shall prepare detail test procedures in accordance with paragraph 5.1.3, MIL-STD-781, except as specified in the following amendments, and submit these procedures in accordance with the provisions of paragraph 3.2.1.2 of this document.

4.1.3.1 The number of test units to be subjected to reliability testing shall be as specified in paragraph 4.4 for the particular reliability test being performed.

4.1.3.2 The contractor shall include, as a part of his test procedure, the equipment environmental and cycling requirements specified in paragraph 4.2 of this document.

4.1.3.3 The contractor shall include, as a part of his test procedure, the performance measurement requirements specified in paragraph 4.4.4 of this document.

4.1.3.4 The contractor shall include, as a part of his test procedures, the failure criteria specified in paragraphs 4.4.4 and 4.5.1 of this document.

4.1.3.5 The contractor's procedures shall not include provisions for preventative or any other type of maintenance to be performed on the equipment during the performance of the reliability tests. In the event such maintenance is performed, a relevant failure will be considered to have occurred and will be charged as such in the computation of test results, as specified in paragraph 5.1 of this document. Preventative maintenance may be performed on the test facility as required to insure completion of the reliability tests.

4.1.4 Inspection: The Government reserves the right to assure compliance with the reliability requirements of this document in accordance with paragraph 5.1.4, MIL-STD-781.

4.1.5 Thermal Survey. A thermal survey shall be conducted in accordance with paragraph 5.1.5, MIL-STD-781. The results of this survey shall be presented as required under the provisions of paragraph 4.1.3 of this document.

4.1.6 Vibration Survey. A vibration survey shall be conducted in accordance with paragraph 5.1.6, MIL-STD-781.

4.1.7 Burn-In (or Debugging) Period. The contractor is authorized to operate the equipment for a certain time prior to the initiation of reliability testing in accordance with paragraph 5.1.7, MIL-STD-781. If the contractor elects to exercise this option, complete details of the burn-in procedure shall be contained in the detailed test procedures submitted in accordance with paragraph 4.1.3 of this document.

4.2 Equipment Cycling. The required portion of the reliability test procedure specified in this document makes provisions for testing under three (3) operational conditions. The following paragraphs outline the cycling provisions which are imposed.

4.2.1 Equipment On-Off Cycling. With the exception of the on-off cycling requirements of the environmental temperature test portion of the reliability test, the equipment shall be operated continuously in the "ON" condition throughout the performance of the reliability test. For the purposes of the reliability tests of this document, test time accumulated for reliability test computations is defined to be only that time in which the equipment is operating in the "ON" condition.

4.2.2 Duty Cycle. The duty cycle of the equipment during the performance of the reliability tests required in this document shall consist of operation under conditions of standard load and standard speed (as defined in paragraphs 4.5.4 and 4.5.5, MIL-G-5413D) for approximately fifty (50) minutes of each operating hour and operation under standard load conditions and 350 rpm for the remainder of each operating hour.

4.2.3 Temperature Cycling. Temperature cycling shall be accomplished as specified in TEST LEVEL G and paragraph 5.2.3.1, MIL-STD-781.

4.2.4 Vibration. Vibration shall be applied to the equipment, during the performance of the vibration endurance portion of the reliability tests, in accordance with TEST LEVEL G and paragraph 5.3.2, MIL-STD-781 with the exception that vibration shall be applied continuously when the equipment is operating.

4.3 Test Facilities. Test facilities proposed by the contractor shall be capable of maintaining the conditions specified for the applicable test level and of measuring equipment characteristics to the specified accuracy for the duration of the test. The proposed test facilities shall be subject to the approval of the contracting officer in accordance with the provisions of paragraph 5.3, MIL-STD-781.

4.4 Test Procedures. The contractor shall include provisions for accomplishing the following mandatory requirements in the detailed reliability test procedures submitted under the provisions of paragraph 4.1.3.

4.4.1 Test Sample.

4.4.1.1 First Article Reliability Test Sample. From the field of eighteen (18) first articles available for reliability testing, twelve (12) equipments shall be selected for initial use in performance of the first article reliability test. The remaining six (6) units shall be held in reserve and used as replacement items for failed units during the test. From the field of twelve (12) equipments to be used in testing, the contractor shall specify the number of equipments which shall be used to meet the requirements of the three (3) environmental test portions of the reliability test, except that at least three (3) equipments shall be used for each portion of the test and the evaluation of test results shall be based upon an equal accumulation of operating test time for each test portion during any given point in time of the test. The above scheme is designed to allow timely completion of first article testing by allowing the contractor to compensate for the on-off cycling requirements of the environmental temperature test.

4.4.1.2 Production Reliability Test Sample. Production reliability test samples shall be selected from each lot of one-hundred (100) units produced after the start of production as specified in paragraph 3.3.1 of this document. Each sample shall be placed on test as it becomes available until such time as a maximum of fifteen units are under test simultaneously. All subsequent samples selected from production lots shall be held in reserve and used only as replacements for units failing during performance of the reliability test.

4.4.1.2.1 Test Length. The test sample size specified for the performance of the production reliability test has been selected with the intent of insuring that a time related pattern failure is not inherent in the equipment design. Therefore, it shall be a requirement of this document that the scheduling of the production reliability test be such that at least four (4) of the test samples shall demonstrate the capability of operating for a minimum of one-thousand (1,000) hours without failure. The test plan submitted in accordance with paragraph 3.2 of this document shall include the method the contractor shall use in assuring that the requirements of this paragraph are accomplished.

4.4.2 Preparation for Test. The test procedures submitted by the contractor in accordance with paragraphs 3.2.1 and 4.1.3 of

this document shall describe in detail the procedures to be used in preparing for the start of the reliability tests. This description shall include details of the installation of equipment, testing of the test facility set-up, burn-in procedures if specified and calibration of test facility equipment in accordance with paragraph 5.4.2, MIL-STD-781.

4.4.3. Reliability Test Methods. The reliability tests performed in accordance with this document shall consist of testing under three (3) environmental conditions. These conditions shall consist of an environmental temperature test, an environmental vibration test and a misaligned drive test. At the option of the contractor, these tests may be performed simultaneously. The details concerning the requirements of these tests are as follows:

4.4.3.1 Environmental Temperature Test. The environmental temperature test shall be performed as follows:

4.4.3.1.1 Environmental Temperature Cycling. The environmental temperature cycling shall be in accordance with the requirements of TEST LEVEL G and paragraphs 5.2.3.1, 5.4.3, 5.4.4. and 5.4.5.1 of MIL-STD-781.

4.4.3.1.2 Duty Cycle. The duty cycle of the equipment under the conditions of this test shall consist of operation under conditions of standard load and standard speed, as defined in paragraphs 4.5.4 and 4.5.5, MIL-G-5413D, for approximately each fifty (50) minutes of equipment operation and under conditions of standard load and 350 rpm for the remainder of each operating hour.

4.4.3.1.3 Equipment Performance During Test. During this test the equipment shall demonstrate the capability to meet the following requirements.

4.4.3.1.3.1. When operating under conditions of standard speed and standard load, the voltage at each of the three (3) generator terminals, shall be between 19.5 and 21.0 volts r.m.s. when measured at the generator terminals.

4.4.3.1.3.2 When operating under conditions of standard load and 350 rpm the voltage at each of the three (3) generator terminals shall be not less than 5.4 volts r.m.s.

4.4.3.1.4 Oil Leakage. During the performance of this test the unit shall be installed with the shaft in a horizontal position with one of the drain holes located at the bottom. The test facility shall include provisions for applying an oil pressure of one (1) psig using an oil conforming to MIL-L-6082 to the shaft end of the unit. Under the above conditions the unit must demonstrate the capability of restricting the oil leakage to less than two cubic centimeters per hour. The contractor shall include a description of how he intends to perform this test in the test plan submitted in accordance with paragraph 4.1.3 of this document.

4.4.3.2 Environmental Vibration Test. The environmental vibration test shall be performed as follows:

4.4.3.2.1 Environmental Vibration. Vibration shall be applied to the equipment during this test in accordance with TEST LEVEL G and paragraph 5.3.2, MIL-STD-781 with the exception that vibration shall be applied continuously whenever the equipment is operating for the purpose of accumulating test time.

4.4.3.2.2 Duty Cycle and Performance Requirements. The duty cycle and performance requirements of equipment during this test shall be the same as specified for the environmental temperature test in 4.4.3.1.

4.4.3.3 Misaligned Drive Test. The misaligned drive test shall be performed as specified in paragraph 4.6.14, MIL-G-5413D with the following exceptions.

4.4.3.3.1 Duty Cycle and Performance Requirements. The duty cycle and performance requirements during this test shall be as specified per the environmental temperature test in 4.4.3.1.

4.4.3.3.2 Backlash. No requirement for measuring the backlash as defined in paragraph 3.4.4.3, MIL-G-5413D, shall exist except as required in determination of failure modes.

4.4.3.3.3 Test Time Requirements. The operating test time requirements shall be as specified in this document.

4.4.3.4 First Article Reliability Test Plan. Test Plan VII, MIL-STD-781 shall be used as the basis for determination of compliance with the reliability requirements of this document during the first article reliability test.

4.4.3.5 Production Reliability Test Plan. Test Plan II, MIL-STD-781 shall be used as the basis for determination of compliance with the requirements of this document during the production reliability test.

4.4.4 Measurements. Measurement of each of the required equipment performance parameters shall be accomplished and recorded at least once daily. These measurements shall be scheduled such that a comparison of each of the three (3) environmental test conditions can be performed on the basis of equal accumulation of operating test time. If the value of any of the specified equipment operating parameters is not within the tolerances specified in paragraphs 4.4.3 and 4.5.1 of this document, a failure shall be recorded and the unit replaced with a new item from the reserve of samples held for reliability test purposes. For recording purposes, a failure shall be presumed to have occurred immediately following the last successful measurement of the same parameter. The contractor shall include the details of the recording procedure which is to be used in the test plan submitted in accordance with paragraph 4.1.3 of this document.

4.5 Failure Actions. On the occasion of a failure, entries shall be made on the appropriate data logs and the failed equipment shall be removed from test. The absence of one or more equipments from test shall in no way affect the ability to make decisions from log data except to the extent that evaluation of test results shall be based upon an equal accumulation of test time in each of the three (3) environmental test modes.

4.5.1 Definition of Failure. For the purposes of performing the reliability tests specified in this document, a failure shall be defined to have occurred under any one (1) of the following three (3) conditions:

(1) A failure shall be considered to have occurred when the tachometer-generator fails to provide a voltage between the limits of 19.5 and 21.0 volts r.m.s. at each of the three (3) terminals when operated under conditions of standard speed and standard load as defined in MIL-G-5413D.

(2) A failure shall be considered to have occurred when the tachometer-generator fails to provide a minimum of 5.4 volts r.m.s. at each of the three terminals when operated under conditions of standard load and 350 r.p.m.

(3) A failure shall be considered to have occurred when the oil leakage exceeds a rate of two (2) cubic centimeters per hour when operated with a pressure of one (1) psig applied to the shaft end of the unit.

4.5.2 Failure Categories. The types of failures and required actions are as specified in MIL-STD-781, paragraph 5.5.1.

4.5.3 Analysis of Failures. The cause of each equipment or part failure shall be determined by investigation and analysis. The investigation and analysis shall consist of any applicable method (such as test, application study, dissection, X-ray analysis, microscopic analysis, or spectrographic analysis) which is necessary to determine the cause of failure. The details of the investigation of each failure shall be reported to the procurement activity and shall become a part of the data and records necessary to satisfy the award and/or penalty clauses of this procurement action. Unless it can be clearly shown by the offeror that the failure of the unit was not a relevant failure, the failure shall be counted in the total number of equipment failures, for test evaluation purposes.

4.5.4 Failure of the Reliability Tests. If a reject decision is reached at any time during reliability tests, all testing shall be discontinued and the procurement activity shall immediately be notified of the reject decision. The results of any testing or the accumulation of any additional equipment operating time after the reject decision has been reached shall be considered irrelevant data and shall not constitute a part of the reliability test results unless otherwise deemed appropriate by the procuring activity.

5. DETERMINATION OF COMPLIANCE: Unless otherwise specified in the contract, determination of compliance with the requirements of this Statement of Work shall be in accordance with the provisions of MIL-G-5413D and paragraph 5.4.8, MIL-STD-781 as amended within this Statement of Work.

5.1 Test Evaluation Criteria. For the purposes of test evaluation, the accept/reject criteria of the reliability test plan being performed shall be applied after each failure and on the basis of equal accumulation of test time among the three (3) environmental condition tests in progress. This requirement shall be applied at the time during the tests when the accumulated test time for each of the three (3)

environmental condition tests equals or exceeds the accumulated test time of the environmental test mode in which the failure occurred. The accumulative time used in this evaluation shall not include operating time accumulated in either of the other operating modes in excess of the accumulated time to failure in the mode in which the failure occurred.

5.2 Computation of Unbiased Estimate of Service Life. Following the completion of each of the reliability tests specified in this document, an unbiased estimate of the mean service life for the production quantity of items to be provided to the Government shall be computed. This unbiased estimate shall be computed by dividing the cumulative testing on-time at the completion of the test by the number of failures observed at the time of completion of the test. For the purpose of this computation the cumulative testing on-time shall be defined as specified in paragraph 5.1 of this document. The value so computed shall be denoted by θ. This value of θ shall be used by the contracting officer in exercising the various options available to the Government as specified in the special provisions section of the contract.

5.3 Accept. If an accept decision results during the performance of the production reliability test specified in this Statement of Work and no pattern failures are evident, all equipments to be delivered to the Government may be accepted, subject to the quality assurance provisions of MIL-G-5413D as amended by this Statement of Work and in accordance with the contract.

5.4 Failure of First Article Tests.

5.4.1 Failure of Quality Conformance Inspection Requirements. In the event the contractor is unable to demonstrate the capability of his equipment to meet the requirements of the Quality Conformance Inspection Requirements of MIL-G-5413D, as amended by this document, the Government reserves the right to terminate the contract under the provisions set forth in the contract.

5.4.2 Failure of First Article Reliability Test Requirements. In the event a reject decision is reached during the performance of the first article reliability test, the contractor shall be subject to the penalties set forth in the special provisions section of this contract.

5.5 Failure of Production Tests.

5.5.1 Failure of Quality Assurance Tests. The provisions of MIL-G-5413D as amended by this document and as specified in the contract shall govern with respect to quality assurance provisions imposed during production.

5.5.2 Failure of Production Reliability Test. In the event a reject decision is reached during the performance of the production reliability test specified in this document, the contractor shall be subject to the penalties set forth in the special provisions section of the contract.

5.6 Analysis of Failure. The cause of each equipment failure shall be analyzed in accordance with paragraph 5.5.2, MIL-STD-781.

5.7 Failure Confirmation. The provisions of paragraph 5.5.3, MIL-STD-781, with regard to failure confirmation shall apply.

5.8 Test Records. The provisions of paragraph 5.10, MIL-STD-781, shall apply with regard to maintaining test records and reports.

5.9 Reliability Test Reports. Reliability reports shall be submitted by the contractor to the procuring activity in accordance with paragraphs 5.11.1 and 5.11.2, MIL-STD-781.

5.10 Determination of Compliance of First Article Requirements.

5.10.1 The first article tests specified within this statement of work shall be conducted at the contractor's plant or an approved testing laboratory and witnessed by a Government inspector. Within ten (10) days of completion of the first article performance, electrical and mechanical tests specified herein, the contractor shall submit a certified test report in accordance with MIL-T-9107 (USAF) along with one (1) first article sample to OCAMA (OCNECE) for inspection and appropriate tests. The first article shall be inspected and/or tested and the test report shall be reviewed to determine compliance with the requirements of this statement of work. Within thirty (30) days of receipt of the first article sample and test report, the contractor shall be notified of the results of this determination. In the event of a determination of compliance, the contractor shall be authorized to proceed with the first article

reliability tests specified within this statement of work. In the event that deficiencies exist, the contractor shall submit a report, within twenty (20) days of receipt of this notification, to the contracting officer outlining how these deficiencies are to be corrected. Unless this report offers clear and compelling evidence that the deficiencies can be corrected, the Government reserves the right to terminate the contract for cause.

5.10.2 Determination of First Article Reliability Test Compliance. Within ten (10) days of the completion of the first article reliability test, the contractor shall submit two (2) copies of all test records, reports, and other pertinent data required by this statement of work to OCMA (OCNER) for determination of compliance with the requirements of this document. Within twenty (20) days of receipt of this data, the Government shall notify the contractor of the results of this determination. In conjunction with this notification and contingent upon the outcome of this determination, the contractor shall either be given approval for forward production of the quantity of items to be delivered to the government under the contract or be notified of any penalties or other provisions of the contract to be invoked by the Government as a result of noncompliance with the requirements of this document.

5.11 Determination of Compliance During Production.

5.11.1 Quality Assurance During Production. The determination of quality assurance during production shall be in accordance with MIL-G-5413D.

5.11.2 Determination of Production Reliability Compliance. Within twenty (20) days of completion of the production reliability test, the contractor shall submit two (2) copies of all test records, test report, and other pertinent data specified by this statement of work to OCAMA (OCNER) for determination of compliance with the requirements of this document. Within thirty (30) days of receipt of this data, the government shall notify the contractor of the results of this determination and of any penalties resulting from a determination of noncompliance.

CASE 5

T-38 AIRCRAFT TIRES

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CASE 5

T-38 AIRCRAFT TIRES

This Case is based on IFB F42600-69-B-1156 and Contract No. F42600-69-C-2214 fo~ a procurement of aircraft tires sufficient to provide 1,184,760 landings.

The procurement of this equipment has almost become a classic in the application of LCC to non-reparables. It is a good example of the use of performance criteria in procurement.

EQUIPMENT DESCRIPTION AND BACKGROUND

The tires are officially listed as:

Tire, Main Landing, 20 x 4.4
12 Ply Rubber S/N 2620 554 2458

Two of these tires are used on the T-38 aircraft and one is used on the F/RF-84. They are manufactured to the specifications in MIL-T-5041E 61432147 and USAF Drawing 60B501, Revision G.

The tire is a qualified products list (QPL) item, with three companies on the QPL.

TABLE 5A

LIFE CYCLE COST ELEMENTS - CASE 5

Initial

Purchase Price - INCLUDED

Delivery (Transportation) - INCLUDED

Testing - N.I. Not necessary under procurement plan. Testing was performed separately prior to issuance of the IFB.

Installation - INCLUDED

Inventory Mgmt. - N.I. Element built-in.

Training - N.I. Not needed.

Operating

Item Life - INCLUDED

Operating Labor - N.I. Not applicable.

Materials - N.I. Not applicable.

Utilities - N.I. Not applicable.

Training - N.I. Not applicable.

Preventive Maintenance - N.I.

Corrective Maintenance - N.I.

Inventory Needs - N.I. Element built-in.

Final

Dismantling - INCLUDED

Residual Value - N.I.

N.I. = Not Included

LIFE CYCLE COST ELEMENTS

Four elements of life cycle cost (service life, transportation, installation, and removal), in addition to purchase price, are included (Table 5A, page 3).

SERVICE LIFE — Tires were purchased from each manufacturer on the QPL with the understanding that the tires were being purchased for the purpose of establishing their expected service life and that they were representative of normal production items. Actual service tests were then made at Williams AFB, Arizona, and the numbers of landings per tire were found to be:

Company	Landings/Tire
A	109.9406
B	59.8139
C	41.9465

The landings per tire then were defined as Landing Indexes and the subsequent IFB and contract were based on the number of landings desired.

The IFB provides that the government may retest delivered production tires under the same conditions as the original test. If the retests yield a lower Landing Index than that included in the contract, the manufacturer must deliver sufficient additional tires to give the desired total number of landings without additional cost to the government.

The Landing Index testing procedure allows for the introduction of new tire designs or manufacturers, assignment of a Landing Index value and placement on the QPL.

The appropriate portions of the IFB are:

	ITEM	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	26205542458 TIRE Aircraft Pneumatic, Size 20x4.4, 12 PR, Reinforced rubber tread, 174 knots, Type VII. Manufactured in accordance with Specification MIL-T-5041E and USAF Drawings 56D1171G, 60B501G, and 61A32147F. Appl T-38 MLG/F-84 NLG AF Repl Spares	10,776	ea		
2	Same as Item 1 above	19,807	ea		
3	Same as Item 1 above	28,245	ea		

* * * *

NOTICE TO OFFERORS:

Procurement will be made for quantities of tires which will provide the number of landings as indicated below. Offers shall be submitted in the space provided for the item(s) which corresponds to the landing index established by each offeror in prior Government Service Evaluation Tests at Williams Air Force Base, Arizona. (See Schedule Clause "A")

The quantity of tires upon which each offeror shall submit offers has been computed according to the following formula:

$$\frac{\text{NUMBER OF REQUIRED LANDINGS}}{\text{LANDING INDEX LOWER LIMIT (XLL)}} = \text{QUANTITY OF TIRES ON WHICH OFFERS SHALL BE SUBMITTED}$$

NUMBER OF LANDINGS REQUIRED	LANDING INDEX (XLL) Company A	Company B	Company C	ITEM NR	QUANTITY
1,184,760	109.9406			1	10,776
		59.8139		2	19,807
			41.9465	3	28,245

* * * *

LANDING INDEX WARRANTY

(1) The bidder warrants that production tires delivered under any contract resulting from this Invitation for Bids will provide a landing average equal to or greater than the Index (XLL) upon which the award was based, with a confidence level of 95%, when retested under similar circumstances as follows:

The Government reserves the right to conduct a new controlled Field Service Evaluation of such production tires at the same Air Force Base and under similar circumstances and conditions as the original test was conducted.

(2) If such retests are deemed necessary by the Government the Contractor shall be notified in writing of the date that a new service test will be conducted. Notice of new Field Service Test may be given by the Government at any time within 180 days after final scheduled delivery under this contract, notwithstanding the fact that further extension of time may be required in order that the time period of any retest will coincide with the time period of the original test. Tires shall be selected from Air Force stock from the production tires received under this contract. If, upon completion of the test, the new landing average does not meet the above criteria the Contractor shall provide additional tires to make up the difference in the number of landings lost. The date of manufacture of the majority of the sample lot selected for retesting will establish the effective date from which to compute the number of tires due to the Government under this warranty. See formula for computing replacement tires in example set forth below. Delivery of replacement tires will be at the same monthly rate as called for in this contract for the tires already delivered and delivery shall commence not later than 30 calendar days after notification of the results of the new service test. Replacement tires shall be shipped, transportation charges prepaid by the Contractor.

(3) The following is an example of the method which will be used by the Government in determining the number of tires requiring replacement under this warranty.

Example:

Contract Awarded for 1,000 Tires:

NUMBER TIRES		LANDING INDEX (XLL)		NUMBER LANDINGS
1,000	X	20	=	20,000

After delivery of 300 tires a sample lot of 125 tires is selected from production tires for retesting. The test results are:

NUMBER TIRES		NEW AVERAGE LANDINGS (95% CONFIDENCE)		NUMBER LANDINGS
125	X	15	=	1,875

The number of tires as replacement is computed as follows:

NUMBER TIRES		NEW AVERAGE LANDINGS (95% CONFIDENCE)		NUMBER LANDINGS
125	X	15	=	1,875
700	X	15	=	10,500
175*	X	20	=	3,500
		TOTAL		15,875

20,000 - 15,875 = 4,125

4,125 ÷ 15 = 275**

(4) This Landing Index Warranty (XLL) is in addition to the clause of this contract entitled "Correction of Deficiencies" and in no way abrogates the "Correction of Deficiencies" clause as to any other contract specification requirement, and any notice, remedy, proceeding or other condition not clearly provided for in this clause as to the warranties stated herein shall be governed by the "Correction of Deficiencies" clause.

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*As noted in Section 2 above, only the tires tested and subsequent tires delivered were assigned the new Landing Index. Tires delivered prior to testing retained the original Landing Index assigned.

**275 tires as replacement.

TRANSPORTATION COSTS

The tires were purchased on an F.O.B. Origin basis. Table 5B shows the Air Force-supplied data used in calculating total shipping costs. Delivery is to be made to three Air Force Bases in five equal monthly shipments.

For the purpose of evaluating Solicitations and for no other purpose, the final destinations and percentage of quantities for the supplies will be considered to be as follows:

DESTINATION	PERCENTAGE OF QUANTITIES
OOAMA, Hill AFB UT 84401	20%
Tinker AFB OK 73145	60%
WP AFB, Wright-Patterson AFB OH 45433	20%

MAINTENANCE COSTS

Although the item is a non-reparable, costs are incurred in the removal from and mounting onto the aircraft. Those costs were established by timing actual operations at Randolph Air Force Base, Texas.

1.	Remove and replace wheel on aircraft.	12 minutes @ $1.70/hr	$0.34
2.	Dismount old tire and mount new tire on wheel in shop.	84 minutes @ $2.34/hr.	$3.28
	TOTAL LABOR COST		$3.62 per tire change

TABLE 5B

TRANSPORTATION COSTS - CASE 5

20 x 4.4 Tire

Evaluation of Item 1 Increment A
F42600-69-B-1156
Landing Index

	Company A	Company B	Company C
Total Quantity	10,776 ea	19,807 ea	28,245 ea
Quantity/Month	(A) 2,156 ea	3,962 ea	5,649 ea
Guar Max Wt/Tire	(B) 14.7#	15.0#	13.0#
Total Lbs/Month	(AxB) 31,693#	59,430#	73,437#
	Min Rates/100#	**Min Rates/100#**	**Min Rates/100#**
Hill AFB Ut	$3.44	$2.99	$2.91
Tinker AFB OK	$1.22	$1.02	$ .99
WP AFB OH	$ .71	$ .43	$ .44
	Weight to Dist.	**Weight to Dest.**	**Weight to Dest.**
Hill AFB UT (209)	6,338.6#	11,886#	14,687.4#
Tinker AFB OK (609)	19,015.8#	35,658#	44,062.2#
WP AFB OH	6,338.6#	11,886#	14,687.4#
	Cost/Shipment	**Cost/Shipment**	**Cost/Shipment**
Hill AFB UT	$218.05	$355.39	$427.40
Tinker AFB OK	$231.99	$363.71	$436.22
WP AFB OH	$ 45.00	$ 51.11	$ 64.62
Freight Cost/Shipment	$495.04	$770.21	$928.24
Total 5 Shipments	$2,475.20	$3,851.05	$4,641.20

*Rounded to next higher integer.

BID EVALUATION

As noted in the IFB:

A. EVALUATION OF BIDS:

Award shall be made to that responsible bidder whose Life Cycle Cost is lowest as determined by the following formula:

UNIT PRICE	x	QUANTITY OF EACH ITEM BID	+	TOTAL SHIPPING COST	+	TOTAL MAINTENANCE COST (3.62 x qty of each item bid)	=	LIFE CYCLE COST

NOTE: Offers must be submitted for the total quantity of each item being offered. Partial bids are not acceptable.

The bid data and evaluation are shown on Table 5C. The winner was Company A.

TABLE 5C

BID EVALUATION - CASE 5

No. of Landings = 1,184,760

		Company A	Company B	Company C
1.	Quantity	10,776	19,807	28,245
2.	Unit Price	$ 37.96	$ 28.00	$ 36.24
3.	1. X 2.	$409,056.96	$554,596.00	$1,023,598.80
4.	Total Shipping Cost (Table 5B)	$ 2,475.20	$ 3,851.05	$ 4,641.20
5.	Total Maintenance Cost (3.62 x Row 1.)	$ 39,009.12	$ 71,701.34	$ 102,246.90
6.	Total LCC (3. + 4. + 5.)	$450,541.28	$630,148.39	$1,130,486.90

DISCUSSION

This Case is used as an example of the application of Life Cycle Cost concepts to a non-reparable purchased on a QPL basis. The purchase quantity criterion is units-of-operation (number of landings in this Case) and each company on the QPL may submit one or more items for standardized testing. As a result of the tests, a performance index number is assigned to each QPL product and bids are requested for a varying number of units which will meet the purchase quantity criterion.

Two cost elements are suggested for inclusion in future contracts of this type - inventory holding costs and testing costs.

In this Case, the highest needed quantity is almost three times the lowest. Although the inclusion of inventory holding costs would not have affected the outcome here, it is quite conceivable that such cost could be significant in other circumstances.

Depending on the equipment under consideration, pre-award testing costs could be substantial. Here, testing involved jet aircraft flight under regular operations. Testing costs could be high enough to warrant acceptance of a claim for marginal improvement subject only to post-award test.

In general, however, the technique of pretesting of QPL products and purchase on the basis of desired operating units is recommended.

CASE 6

TRAVELING WAVE TUBE

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CASE 6

TRAVELING WAVE TUBE

This Case is based on Request For Quotation (RFQ) F09603-69-Q-0027 issued by the AMA at Robins AFB. It is realistic rather than real, however, because the award criterion has been simplified and some of the mathematical notation changed to enhance the value of the Case as a guide for people not accustomed to working with statistical testing procedures. RFQ content presented, therefore, should not be considered as direct quotations from Air Force documents.

The Case is used as an example of the application of cost per operating unit in LCC procurements.

CASE DESCRIPTION

The item is a non-reparable, electronic component.

The LCC goal is to minimize cost per operating hour. Based on components now in service, the Air Force has specified a minimum bid[1] Mean Time Between Failures (MTBF) or Mean Time To Failure (MTTF), of 500 hours. Otherwise, the bid will be declared non-responsive.

A logistics cost of $112.64 per unit had been computed as the total cost of transportation, storage, installation, and dismantling for equipments of this type. That figure is included in the bid evaluation as part of the equation used to compute the cost per hour.

Each bidder is required to submit a MTTF, called "bid MTTF" or "bid MTBF," with his bid. The total cost per hour is then calculated as

$$\text{Cost/hr} = \frac{\text{(Unit Price)} + (\$112.64)}{\text{Bid MTTF}}$$

A penalty clause provides for a price reduction if the actual MTTF, established by sampling and test of delivery items, is below the bid MTTF.

The pertinent parts of the RFQ (simplified, as mentioned above) are as follows, and the criteria for the production reliability tests are attached as Appendix A.

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[1] In conformance with USAF practice in the actual procurement, the words "bid" and "bidders" are used to mean proposals and those who submit them.

This is a life cycle cost Request for Quotation. Life Cycle Costing is a method of procurement which will allow the Air Force to evaluate contractors' proposals for equipment and material not just for lowest initial price, but for lowest total life cycle cost. It implements the Armed Services Procurement Act of 1947 which states in part "Award shall be made to the responsible bidder whose bid will be most advantageous to the United States price and other factors considered."

* * * *

	Quantity	Unit
589586235 31EW Traveling Wave Tube. Item is to be furnished in accordance with AFLC/AFSC Form 2 attached, classified specifications referenced herein to be furnished under separate cover; and all other terms and conditions contained herein. Offeror's quotation shall include in addition to prices, a statement of the items mean time between failure (MTBF) or mean time to failure (MTTF) along with the rationale supporting the MTBF - MTTF as defined and described under evaluation provisions contained herein. DO NOT INDICATE PRICE(S) ON DATA SUPPORTING ENGINEERING/TECHNICAL ASPECTS TO BE EVALUATED OR RATIONALE FOR MTBF - MTTF.	648	each

* * * *

TECHNICAL EVALUATION

(a) Based upon field operation of the system(s) upon which the item being procured incident to this solicitation has been used, a mean time between failures (MTBF) has been observed. The Government has ascertained that a satisfactory contribution to Weapon System Effectiveness can be achieved by any item which can pass the Reliability Acceptance Test described elsewhere in this solicitation with a bid MTBF of not less than 500 hours.

(b) The bid MTBF of any given offeror in response to this solicitation shall become the basis for calculation of the minimum acceptable MTBF, θ_1, for the purposes of the post-award Reliability Acceptance Test.

(c) Any minimum acceptance MTBF which is less than minimum specified MTBF/2 (250 hrs) shall be declared nonresponsive to the requirements of this solicitation. (The factor of 2 is the Descrimination Ratio for MIL STD 781 Test Plan IV, which will be used as the statistical element of the Reliability Acceptance Test described elsewhere in this solicitation.)

(d) A failure is as described in MIL STD 781 and further defined in that portion of this Statement of Work relating to Demonstration/Verification. Each offeror responding to this solicitation shall provide as a separate element of his response, a complete rationale supporting the attainability of his proposed MTBF in a controlled test utilizing the environmental profile, and statistical test plan stipulated in that portion of this solicitation relating to Reliability Acceptance Testing. There are no limitations imposed upon the form and content of this rationale, however, each potential offeror is herewith advised that it is incumbent upon each offeror to present a convincing and creditable case in support of his proposed MTBF.

(e) Award will be made to the responsible offeror whose cost per hour of useful tube life is lowest as determined by the following formula.

$$\text{Cost per Hour} = \frac{\text{(Unit Price) + (Unit Logistic Cost)}}{\text{Bid MTBF}}$$

(f) The bid MTBF and substantiating rationale submitted by each Offeror in response to this solicitation shall be reviewed by the expert engineering staff of the Government to ascertain the relative feasibility of attaining an "Accept" decision in the Reliability Acceptance Test otherwise described in this solicitation. Upon review of the bid MTBF and supporting evidence of its reasonableness, the Government reserves the right to elect any of the following options with regard to any offeror who is identified in the proposal evaluation as having the lowest LCC and is otherwise determined to be responsive to all solicitation requirements exclusive of proposed MTBF:

(1) Based solely upon the expert judgment of the Government engineering staff, the Government reserves the right

to conclude that the bid MTBF is not reasonable for the hardware proposed, considering the rationale submitted in support of the bid MTBF. In the event that the Government arrives at the above decision, the Government shall declare the offeror in question nonresponsive to the provisions of this solicitation.

(2) Based solely upon the expert judgment of the Government engineering staff, the Government reserves the right to conclude that the bid MTBF of the offeror is reasonable and attainable for the hardware proposed considering the rationale submitted in support of the bid MTBF. Such a conclusion may be arrived at irrespective of how ordinary or extraordinary the proposed MTBF may appear in comparison to the MTBF observed or alleged to be available from other hardware having the same form, fit, and function.

* * * *

Penalty

If the contractor's Traveling Wave Tubes fail to pass the post award Reliability Acceptance Test as described in Attachment "A" and Test Plan IV of MIL STD 781 a penalty procedure shall apply.

The purpose of this procedure is to prevent the life cycle cost of the tube to the Air Force from rising above that originally proposed. Consideration is given to the confidence level of the reliability acceptance test.

Chart X* reproduces the accept-reject criteria of Test Plan IV, MIL STD 781 (paragraph 4.2.8.4) for illustrative purposes. A and B, the producer and consumer risks respectively, are both 20%. The discrimination ratio (D.R.) is 2, and is the ratio of bid to minimum acceptance MTBF (θ_0/θ_1).

For purposes of this contract, and in the case where reliability verification testing under Test Plan IV leads to a reject decision, the "actual" MTBF (θ) signified by testing shall be defined as the 70% lower confidence limit of the MTBF taken at reject point conditions.

Example: Assume that in the performance of reliability verification testing under Test Plan IV, the 7th item failure occurs at 3.8 θ_0 hours into the test program. (Ref to Test Plan IV will

---

*Not included in this Case presentation.

show that this happens to be the latest time that a 7th failure will produce a reject decision.)

Using this information and the following formula, the 70% lower confidence limit of the MTBF can be determined as a decimal fraction of θ_C, the bid MTBF. The 70% lower confidence limit is denoted θ and called the "actual" MTBF.

$$\theta = \frac{2t}{X^2_{A,2r}}$$

Where t = Total Test Time in Multiples of θ_0

X^2_A = CHI Square Values for the assigned risk function (A = .30) taken at 2r degrees of freedom (ref Table I)

r = Nr of failures

Therefore:

$$\theta = \frac{7.6\ \theta_0}{16.222} = .468\ \theta_0$$

Since (in the case of a Test Plan IV reject decision) the actual MTBF (θ) so determined will always be less than the minimum acceptance MTBF (θ_1), adjustment of the contract price is necessary to avoid a rise in the life cycle cost (unit cost per hour of service life) which is the basis for the award. Adjustment of the contract price in those instances where equipment fails to meet test requirements shall be computed in the following manner:

$$\text{Penalty} = \left(1 - \frac{\theta}{\theta_1}\right) \times (\text{Unit Price} + \text{Logistic Cost}) \times (\text{Number of Units}),$$

where θ = Actual MTBF as defined above and expressed as a decimal fraction of θ_0;

and θ_1 = Minimum acceptance MTBF expressed as a decimal fraction of θ_0 (equals .5 θ_0 because the D.R. is 2).

Using the above example values:

$$\text{Penalty} = \left(1 - \frac{.468}{.500}\right) \times (\text{Unit Price} + \text{Logistic Cost}) \times \text{Units}$$

$$= 6.4\% \times (\text{Unit Price} + \text{Logistic Cost}) \times (\text{Units})$$

NOTE: The fixed figure of $112.64 will be considered to be the Logistic Cost.

TABLE I

DEGREES OF FREEDOM	$X^2_{.30}$
1	1.074
2	2.408
3	3.665
4	4.878
5	6.064
6	7.231
7	8.383
8	9.524
9	10.656
10	11.781
11	12.899
12	14.011
13	15.119
14	16.222
15	17.322
16	18.418
17	19.511
18	20.601

Penalty percentages indicated on Chart X (Test Plan IV, paragraph 4.2.8.4) are approximate and are included for illustrative purposes only. Actual penalties shall be computed from the formula and Table I values. Straight line interpolation shall be used to compute the penalty value for reject decisions occuring between the whole failure number and reject line intercepts. Thus, in the example, if the seventh failure had occurred at less than 3.8 θ_0 hours but more than 3.1 θ_0 hours, the penalty would be calculated from a straight line between approximately 6.4% and 11.6%, the penalty percentages associated with 3.8 θ_0 and 3.1 θ_0.

BID EVALUATION EXAMPLE

The evaluation equation and example calculations are:

$$\text{Cost per hour} = \frac{(\text{Unit Price}) + \text{Logistic Cost}}{\text{Bid MTBF}}$$

$$= \frac{\text{Unit Price} + \$112.64}{\theta_0}$$

Bidder Nr.	Unit Price	Bid MTBF (θ_0)		
1	1000	800	=	$1.39 per hour
2	1750	1500	=	$1.24 per hour
3	2000	3000	=	$0.70 per hour

Award would be made to Bidder 3.

DISCUSSION

This Case is an example of the application of cost per operating unit (i.e. hours) as the prime criterion in an LCC award, with penalties provided for failure to meet promised performance.

Since the procurement is for a non-reparable component, the ownership costs consist of only a few LCC elements which may be expressed as a generalized "Logistic Cost."

The LCC application technique used here differs from that in Case 5 in that testing is conducted after the award. Also note that penalties are applied to defined blocks of production items (i.e. one hundred items).

Thus, this technique may be applied to the procurement of components or parts where pre-award testing is undesirable or a QPL does not exist.

CASE 6

APPENDIX A

STATEMENT OF WORK FOR RELIABILITY TESTING

1. The contract specified (bid) MTBF θ_0 shall not be less than 500 hours under the conditions specified in the following Articles.

QUALIFICATION PHASE OF PRODUCTION RELIABILITY TEST

2. For every 100 items produced a sample size of five (5) units shall be selected at random from the first to the twenty-fifth (25th) items produced for the initial Reliability Test to be conducted in accordance with Test Plan IV of MIL STD 781. The sample size shall be changed to the following size as per proposed minimum acceptance MTBF θ_1:

Minimum Acceptance θ_1	Sample Size
0 - 249 hrs	Non-responsive
250 - 325	5 tubes
326 - 562	6 tubes
563 - 687	7 tubes
688 - 812	8 tubes
813 - 937	9 tubes
938 -4999	10 tubes

The test shall be run with replacement of failed items; both failures and equipment ON time of replaced items shall be counted in determining the accept or reject decisions.

3. Test Conditions

3.1 Tube Temperature: Maximum temperature of hottest spot shall be less than 220°C and greater than 169°C.

3.2 Cooling Air: Air flow of test fixture to be adjusted to maintain the above operating temperature during ON time. Air flow temperature to the fans and TWT shall be 25°C $\pm$ 5°C Ambient.

3.3 Duty Cycle: The TWT shall be operated through at least four consecutive cycles of one hour forty-five minutes ON and fifteen minutes OFF each work day. The TWTs shall be turned OFF for at least 24 hours every weekend. The OFF sequence shall

remove all voltages from the TWT. Air flow shall not be interrupted except during the 24-hour OFF period. The TWT shall be operated in STANDBY mode for at least 7-1/2 hours per work day. The TWT shall be turned OFF for 15 minutes before and after the 7-1/2 hour STANDBY mode. Total STANDBY time shall be at least equal to or greater than equipment ON time. STANDBY time shall not be considered as ON time. Only ON time shall count towards accumulated test time for accept/reject decisions.

3.4 Input Requirements

3.4.1 Supply voltages: Supply voltages and currents to the TWT shall be in compliance with Hallicrafters Drawing No. 150-001504.

3.4.2 Helix Input: Input signal to the helix input terminal shall be a processed signal from the final output of a Transmitting Set associated with the application of this FSN. The total input power shall be less than 2.5 watts and incorporate a manual or automatic attenuator to maintain the input at a constant value at each test monitor check.

3.4.3 STANDBY Mode: Supply voltage to the filament of the TWT shall be 12.6 $\pm$ 1.3 volts AC. Filament current shall be a minimum of 2.5 amperes and a maximum of 3.0 amperes. All other voltages shall be off.

3.5 Output Requirements: R.F. power at output shall be at least the minimum as specified in the Hallicrafters Test Specification for this system. The frequency used during ON time shall be Channel 1, 8, 9, 10 or broadband.

3.6 Procedure: The TWT shall be tested under a load consistent with the requirements of the component system as per Hallicrafters Test Specification. Input power as per paragraph 3.4.1 and 3.4.2 and output load must be applied continuously during the ON cycle and power shall be reported during the ON cycle to determine failures at least every four hours per one eight-hour work shift per day. Each TWT will be tested out of the system. STANDBY filament power must be applied continuously during the STANDBY cycle to determine if a failure has occurred.

4. Burn-In: Burn-in provisions of paragraph 5.1.7 of MIL STD-781 shall apply. Burn-in time shall not be accredited towards Reliability testing time.

5. Failure Criteria

5.1 The equipment shall first meet the Air Force approved production acceptance criteria prior to being placed under the reliability test. Nonacceptance under the production acceptance test shall be considered a failure.

5.2 Failure to meet the output requirements under the input conditions of paragraph 3.4 shall be considered a failure.

5.3 A variation with time of input power by 10% or more under the input conditions of paragraph 3.4 while the TWT is ON shall be considered a failure.

5.4 A variation of any input power during ON and filament power during STANDBY conditions of paragraph 3.4 shall be considered a failure.

5.5 All failures in ON, STANDBY and OFF shall be considered relevant failures unless waivered by the procuring activity. Failures classified as caused by manufacturing/quality control shall not be censored unless the contractor takes positive corrective action and implements the action on all items to be delivered under the contract. The test will then be re-run and an accept/reject decision reached. Such additional testing as may be required in accordance with the above shall be at the expense of the contractor and in no way be reimbursable by the Government.

6. Pattern Failure: Pattern failure, as defined in MIL STD-781, shall require redesign of the end item so as to reduce or eliminate the cause or causes of those failures. In the event that the accumulation of failures including pattern failures precluded an accept decision during the initial test, the test shall be repeated after the results of redesign are incorporated in the test items. In the event that the accumulation of failures including pattern failures permitted an accept decision during the initial test, the proposed design changes shall be given an engineering review by the procuring agency. This review shall form the basis for a decision as to whether retesting is necessary.

7. Preventive Maintenance: Preventive maintenance of associated test equipment is required, but no preventive maintenance of the TWT is permitted during test.

8. Rejection: In the event of a reject decision, corrective action shall be performed in accordance with 5.7 of MIL STD-781. No deliveries shall be made until deficiencies are corrected and substantiated by retest.

9. Delivery: Items used in Qualification Reliability testing shall be delivered as a production item under the contract, if the testing hours of an item is less than 31% of θ_0 hours. Failed items and items with an excess of 31% of θ_0 hours will not be delivered as a production item nor considered as part of the contract quantity.

10. Reports. Reports shall be submitted in accordance with the attached DD Form 1423.

CASE 7

COMPUTER REPLACEMENT

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CASE 7

COMPUTER REPLACEMENT

This Case is based on RFP No. F19628-69-R-0027 made by the EDP Equipment Office, AFSC/ESD, Hanscom Field, Massachusetts.

At the date of case preparation, only the RFP had been issued. However, the contracting office supplied calculation examples to contractors and, together with the wording of the RFP, the information is considered sufficient to indicate the applicability of Life Cycle Costing and the techniques to be used in the procurement.

Subsequent to case preparation, a number of amendments to the RFP were issued. Those amendments have not been included because they did not change the LCC concepts involved or the methodology used.

Minor additions have been made in the summary calculations to conform to DoD Instruction 7041.3, 26 February 1969. Those additions are properly noted.

The Case includes the use of a maintenance contract as an integral part of the purchase. A detailed cost analysis, with the use of probabilities, is a Case highlight.

BACKGROUND AND EQUIPMENT DESCRIPTION

The following portions of the RFP describe the equipment and the procurement requirements.

1-2 Purpose: Solicitation of proposals to replace the present Air Force Cambridge Research Laboratories computer equipment. This consists of an IBM 7094 II/7044 DCS system, three remote IBM 1130 Computers, an IBM 1460 and a UNIVAC 1004 card processor.

* * * *

1-14 Schedule of Events: Major milestones and selected significant data for the project are listed below:

No.	Activity	Dates
1	Issue RFP to Vendors	30 Dec 1968
2	Release Benchmark Material	13 Jan 1969
3	Vendors' Conference	20 Jan 1969
4	Proposal Submission Date	30 Apr 1969
5	Commence Vendors' Presentations	5 May 1969
6	Commence Live Test Demonstration	19 May 1969
7	Announcement of Selection (on or about)	31 Jul 1969
8	Initial Installation (on or about)	30 Apr 1970

* * * *

1-16 Contractual Objectives.

1-16-1 In view of the phased incremental installation permitted by this RFP, one of the prime contractual objectives is a price guarantee for all increments to be installed and all services to be provided during the system life.

1-16-2 Because of the large quantity of equipments involved in this solicitation, quantity discounts and reduced maintenance charges due to the concentration

of the equipments in a single area, are considered appropriate objectives for this solicitation.

1-16-3 Contractual agreement that no maintenance charges and/or extra shift lease charges will accrue for central processing unit components (i.e., memory, channels, and processing units, etc.) which are exclusively dedicated to support of the remote terminals when such terminals are either inoperable or not scheduled for operations.

1-16-4 The contents of the successful offeror's proposal are to be considered contractually binding unless otherwise identified in the contract upon which award is based.

* * * *

2-1 System Concepts:

2-1-1 General System Description: The equipment to be installed will be used by the Air Force Cambridge Research Laboratories (AFCRL) to provide centralized data processing services for the acquisition, reduction and analysis of laboratory data and formulation of computer processing of laboratory data and reduction of scientific data.

2-1-2 Scope: The equipment obtained as a result of this RFP will be installed at the Air Force Cambridge Research Laboratories, L. G. Hanscom Field, Bedford, Massachusetts. The expected life of the system is five years.

* * * *

TABLE 7A

LIFE CYCLE COST ELEMENTS - CASE 7

Initial

Purchase Price - INCLUDED

Delivery (Transportation) - INCLUDED

Testing - Included in purchase price.

Installation and Start-up - Included in equipment price and delivery cost.

Inventory Management - N.I. Not applicable.

Training - N.I. Assumed to be negligible.

Operating

Item Life - INCLUDED

Operating Labor - INCLUDED

Materials - N.I. Not applicable.

Utilities - INCLUDED

Training - N.I. Assumed to be negligible.

Preventive Maint. - INCLUDED

Corrective Maint. - INCLUDED

Inventory Needs - N.I. Not applicable.

Final

Dismantling - N.I.

Residual Value - N.I.

N.I. = Not Included

PROPOSAL EVALUATION

AND

LIFE CYCLE COST ELEMENTS

The RFP clearly states that "total expected costs to the Air Force" will be used in evaluating proposals and further specifies which cost elements are included.

The Air Force, with MITRE's help, prepared a step-by-step cost evaluation format to be filled in by the offerors, explaining the methodology and calculations which will be followed in determining the total Life Cycle Costs. The offerors were asked to submit both purchase and lease alternatives.

The Air Force also provided each prospective vendor with an example of a completed cost evaluation format. The instructions for the calculations are very detailed and the example is self-explanatory.

The instructions and explanatory example as stated by the Air Force have been included rather than a hypothesized set of data. Since DoD Instruction 7041.3 had not been issued when the RFP came out, the original document did not include discounting as an evaluation procedure. The appropriate discounting factors and calculations have been added on the cost summaries - Tables D-4 and D-5.

The Life Cycle Cost elements included in the evaluation (Table 7A) cover the complete range of expected ownership costs except for termination (see Discussion section).

References to technical requirements in the cost data section have been excluded from this Case. However, in the RFP, appropriate attachments have been included covering mandatory

and desirable technical performance criteria. In addition, a demonstration clause (a pre-award testing method) has been included to provide proof that the vendor's equipment is capable of meeting the Air Force's requirements.

The pertinent explanations, instructions, and formats are as follows:

2-3 Evaluation Criteria:

2-3-1 General. The Government will evaluate and validate responsive proposals received, and a selected offeror will be recommended to Headquarters USAF. Equipment proposals which do not meet the mandatory requirements and/or the processing specifications prescribed for the benchmark programs will not be considered for selection. However, the Government reserves the right to conduct written or oral discussions with all responsible offerors who submit proposals within a competitive range, price and other factors considered. If a proposal is reasonably susceptible of being made acceptable by additional information clarifying or supplementing same, the Government in its discretion may permit offerors submitting such proposals to clarify or supplement same. The additional information will be reviewed and evaluated by the Government with the objective of placing the proposal in either an "acceptable" or "unacceptable" category. Offerors are hereby notified, however, of the possibility that award may be made without discussion of proposals received and hence offerors should initially submit proposals on the most favorable terms from a price, technical and other factor standpoint which the offeror can submit to the Government. Equipment proposals meeting the mandatory requirements and satisfying the Life Test Demonstration specifications will be evaluated principally on systems performance and the total cost to the Air Force of implementing these systems.

2-3-2 Specific: The EDP equipment proposed will be evaluated based on the total expected cost to the Air Force. The total expected cost will include the cost of the computer to perform the expected workload, personnel costs, maintenance costs, miscellaneous costs, such as utility costs to satisfy the mandatory requirements

and the additional cost of the desirable features which will enhance the user's operation. A qualitative/ quantitative evaluation of desirable features proposed will be made. The total expected cost to the Air Force will be based on a predetermined worth.

The value of the desirable features stated in Attachment II, Paragraph 5-3, are in the following descending order of magnitude:

1. Symbolic manipulation of mathematical expressions.

2. Continued operation from present AFCRL machine language programs.

3. Hardware diagnostics accounting.

4. Additional Math library routines.

5. Additional program library routines.

6. FORTRAN bit manipulation of mathematical expressions.

7. Extra Character Set (no monetary value assigned-qualitative value only).

Therefore, prospective vendors are encouraged to include in their proposals as many of the desirable features as possible. Vendors are required to make definite statements relative to their capability to provide each of the desirable features listed in Attachment II. The vendor should identify, describe and if possible show the separate cost to the Government for each of the desirable features that will be provided.

* * * *

3-2 Proposal Format:

3-2-1 Each proposal will be submitted in four parts, each separately bound and preferably in loose leaf binders and as outlined in Exhibit 1.

Part I - System Proposal

Part II - Technical Data

Part III - Cost Data

Part IV - Air Force Contract

3-2-2 Cost Data: Care should be exercised to insure that no cost data of any kind are included in Parts I or II of the proposal.

* * * *

Section 1. Cost Data

1-1 Cost Tables. Cost Tables D-1, D-2, D-3, D-4 and D-5 will be completed in accordance with instructions furnished. (Attachment 1, Chapter 3, Exhibits 6, 7, 8, 9 and 10).

1-2 Cost Questionnaire. The Cost Questionnaire, Table D-6, will be completed in accordance with instructions furnished in Attachment 1, Chapter 3, Exhibit 11. Include a positive statement as to the guaranteed price period involved for any service, hardware, or software proposed. All questions must be answered. Additional appendices to augment specific replies may be submitted.

1-3 Special Cost Elements. Describe any special discount (equipment, training, education, etc.) or price/cost concessions which may or may not appear elsewhere in Part III of the proposal, but which are deemed sufficiently advantageous to the Government to warrant special notice or emphasis.

* * * *

3-3 Tables and Instructions:

d. Cost Tables and Questionnaire (Exhibits 6, 7, 8, 9, 10 and 11)

The following cost tables and questionnaire will be submitted in Part III, Section 1, of the proposal:

(1) Table D-1

(2) Table D-2

(3) Table D-3

(4) Table D-4

(5) Table D-5

(6) Table D-6[1]

* * * *

[1]Table D-6 is the Cost Questionnaire. It may be helpful for the reader to scan that questionnaire (pp. 43 through 47) before reading the other tables.

COST DATA

INSTRUCTIONS FOR TABLE D

1. The following cost tables and questionnaire will be submitted for each proposed system:

a. Table D-1. Equipment and Maintenance Costs - Lease/Purchase Basis.

b. Table D-2. Probabilistic Workload Calculations for:

I. Equipments - Leased System.

II. Maintenance - Leased System.

III. Maintenance - Purchased System.

IV. Utilities - Leased and Purchased Systems.

V. Personnel - Leased and Purchased Systems.

c. Table D-3. Probabilistic Workload Calculations-Equipment Purchase and Transportation.

d. Table D-4. Expected Cost Summary - Leased System.

e. Table D-5. Expected Cost Summary - System Purchase.

f. Table D-6. Cost Questionnaire.

2. The cost tables and questionnaire will be submitted in Part III, Section 1, of the proposal. If additional tables are submitted, they should be clearly labeled to facilitate understanding of the proposal.

3. Include supplementary written explanations necessary to expand on entries where required. If special or additional features must be attached to a component to complete the processing requirements, list and price the features beneath the component concerned. In addition, furnish a statement of lease/purchase options and maintenance charges for purchased equipment by component. All cost figures will reflect any discounts which apply.

INSTRUCTIONS FOR TABLE D-1

EQUIPMENT AND MAINTENANCE COSTS - LEASE/PURCHASE BASIS

(See Exhibit 6 (Table), This Attachment)

Column 1 - Equipment Model Number: Enter the model number for each component of the proposed system. Purchase only items and/or one-time charges will be annotated with an asterisk (*). Equipment is to be grouped as follows with subtotals for each group and a total for all groups where indicated:

a. Central Processor. Under Central Processor, list all proposed devices and/or features related to the Central Processor.

b. Input/Output (I/O). Under Input/Output, list all proposed input/output components including related control units and devices.

c. IAS. Under IAS, list the proposed IAS components including special devices and/or features.

d. Remotes. Under Remotes, list the proposed components including any interface components or special devices.

Column 2 - Equipment Description: Enter a brief descriptive title corresponding to the model number.

Column 3 - Quantity: Enter the quantity of units of each component proposed.

Column 4 - Lease Basic Time Period: Enter the Basic Monthly Rental time for each component proposed.

Column 5 - Lease Basic Monthly Rate: Enter the Basic Monthly Rental cost for each component proposed (unit rate multiplied by quantity).

Column 6 - Lease Extra Use Hourly Rate: Enter the Extra Use Hourly Rate for each component proposed (unit rate multiplied by quantity).

Column 7 - Unit Purchase Price: Enter the unit purchase price of the equipment proposed.

Column 8 - Total Price: Enter the product of the Unit Purchase Price in Column 7 and the Quantity in Column 3.

Column 9 - Basic Monthly Maintenance Charge: Enter the Basic Monthly Maintenance Charge corresponding to the initial schedule of maintenance charges (indicate the period covered).

Column 10 - Required Monthly Maintenance Charge: Enter the Monthly Maintenance Charge (Basic Monthly Maintenance Charge plus any additional maintenance charges) to meet the mandatory maintenance requirements of this RFP.

Column 11 - Total Monthly Maintenance Charge: Enter the product of the Required Monthly Maintenance Charge (column 10) and the Quantity (column 3).

Column 12 - Months to Breakeven: Enter the number of months required to breakeven for each item of equipment calculated by the following formula:

$$\text{Months to Breakeven} = \frac{\text{Purchase Price}}{\text{Mo. Lease Price minus Mo. Maint. Cost}}$$

Column 13 - Price Reference: Indicate the page number in your Air Force contract or other price list where the item proposed is listed.

TABLE D-1

EQUIPMENT AND MAINTENANCE COSTS
LEASE/PURCHASE BASIS

COMPUTER SYSTEM ____________

PAGE NO. ____________

1	2	3	4	5*	6*	7	8*	9	10	11*	12	13
EQUIPMENT			LEASE			PURCHASE		MAINTENANCE				
MODEL NO.	DESCRIPTION	QUANTITY	BASIC TIME PERIOD	BASIC MONTHLY RATE	EXTRA USE HOURLY RATE	UNIT PRICE	TOTAL PRICE	BASIC MONTHLY CHARGE	REQ'D MONTHLY CHARGE	TOTAL MONTHLY CHARGE	MONTHS TO BREAK EVEN	PRICE REFERENCE

* Enter Subtotals for Each Group and Totals for All Groups.

EXHIBIT 6

INSTRUCTIONS FOR TABLE D-2, I

PROBABILISTIC WORKLOAD CALCULATIONS

(See Exhibit 7a (Table), This Attachment)

I. EQUIPMENT - LEASED SYSTEM

Column 1 - Operational Year: Enter the specific operational year for which the calculations are being made.

Column 2 - Workload Probability Level: Enter the probability levels from Table 4-5-1, Attachment II of this RFP.

Column 3a - Chargeable Use Time (C.U.T.): Enter the total chargeable use time from Table B of this RFP for each appropriate workload probability level and operational year. All equipments that have the same C.U.T. may be grouped together on one Table D-2. Each Table D-2 must be clearly labeled to indicate which equipments are being referenced. All devices listed in Table B must be accounted for in these tables.

Column 3b - Operational Use Time (O.U.T.): Enter the total operational use time from Table B of this RFP for each appropriate workload probability level and operational year.

Column 4 - Computer System: If more than one primary processing system is being proposed, without simultaneous installation, indicate "I" for the initial increment and "F" for the final configuration corresponding to the C.U.T. entered in Column 3a. If only one system is proposed, or, if two primary processing systems are proposed to be initially installed simultaneously, indicate "F" for final configuration.

Column 5 - Workload Probability by Segment: Enter the differences between each successive pair of workload probability levels (Column 2) for each operational year. Since the entries in Column 2 are cumulative probabilities, the differences represent the probability that the time required by the proposed system(s) to perform the actual workload will fall in the segments between the C.U.T. (Column 3a).

Column 6 - Uniform Cost Subsegments: Enter the values of the C.U.T. that divide the segments between the Column 3a entries into subsegments over which the lease rates vary uniformly. In general, such discontinuities (or breakpoints) occur due to shift transitions, modifications of the computer configuration, etc., as applicable. For a breakpoint that corresponds to a transition from the initial increment (I) to the final configuration (F), note this transition by inserting "I" and "(F)" in the same entry in Column 4. Also enter in parentheses in Column 6 the C.U.T. for the final configuration (F) that corresponds to the specified breakpoint for the initial increment.

NOTE: In the event that C.U.T. differs from O.U.T., the C.U.T. that corresponds to the maximum allowable O.U.T. (550 hours) should be used to determine the necessity for system modification.

Column 7 - Number of Systems: Enter the number of primary processing systems being referenced.

Column 8 - Subsegment Time Increment: Enter the differences between each successive pair of entries in Column 6 for each operational year. These differences are the number of hours in each subsegment defined.

Column 9 - Workload Probability by Subsegments: Divide the length of each subsegment in Column 8 by the difference between each corresponding pair of C.U.T. in Column 3a (i.e., the length of the parent segment) and multiply the result by the value of the Workload Probability by Segment (Column 5) and enter the result. This represents the probability that the time required by the proposed system(s) to perform the expected workload will fall in the subsegment defined in Column 6.

Column 10 - Average Chargeable Use Time for Subsegment: Add one-half (1/2) of the subsegment length (Column 8) to the lower limit of the subsegment defined in Column 6 and enter the sum as the average chargeable use time for subsegment.

Column 11 - Extra Use Time: Enter the Chargeable Monthly Extra Hours if applicable (subtract from Column 10 the total basic use time for the system defined in column 4, Table D-1, or the total basic use time for the number of systems defined in Column 7).

Column 12 - Basic Monthly Use Cost: Enter the basic use cost per month for the system defined in Column 4 or for the number of systems defined in Column 7 (include costs for all the computer components grouped in this table).

Column 13 - Extra Monthly Use Cost: Enter the product of the Extra Use Hourly Rate (Table D-1, Column 6) and the Extra Monthly Use Chargeable Time (Table D-2, Column 11). Use the total rate for all the computer components grouped in this table.

Column 14 - Total Monthly Cost: Enter the sum of the Basic Monthly Use Cost (Column 12) and the Extra Monthly Use Cost (Column 13).

Column 15 - Expected Total Cost Per Year: Enter the product of the Total Monthly Cost (Column 14), the number of months in a year (i.e., 12), and the probability that the cost in question will be incurred (i.e., the workload probability of the subsegment in Column 9). The expected total costs should be added for each operational year and entered in the appropriate place in Table D-4, Expected Cost Summary.

TABLE D-2, I

PROBABILISTIC WORKLOAD CALCULATIONS
EQUIPMENT - LEASED SYSTEM

DEVICE IDENTIFICATION:_____

1	2	3a	3b	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB LEVEL	CHARGE-ABLE USE TIME	OPERATIONAL USE TIME	COMP. SYS.	WL PROB BY SUBSEGMENT	UNIFORM COST SUBSEGMENT	NO. OF SYS.	SUBSEGMENT TIME INCR.	WORKLOAD PROB BY SUBSEGMENT	AVG. C.U.T. FOR SUBSEGMENT	EXTRA USE CHARGE-ABLE TIME	BASIC MO. USE COST $40,795/MONTH	EXTRA MO. USE COST $23/HR.	TOTAL MO. COST	EXP. TOTAL COST/YEAR
						165.0									
1	1.0	165.0	181.5	I	0.5		1	11.0	.22	170.5	0	40,795	-	40,795	107,699
	0.5	190.0	209.0			176.0									
					0.5		1	14.0	.28	183.0	7	40,795	161	40,956	137,612
	0.0	215.0	236.5			190.0									
							1	25.0	.50	202.5	26.5	40,795	610	41,405	248,430
						215.0									
2	1.0	330.0	363.0	I		330.0									
					0.5		1	50.0	0.5	355.0	179.0	40,795	4,117	44,912	269,472
	0.5	380.0	418.0			380.0									
					0.5		1	50.0	0.5	405.0	229.0	40,795	5,267	46,062	276,372
	0.0	430.0	473.0			430.0									
3	1.0	495.0	544.5	I		495.0	1								
					0.5			5.0	.03	497.5	321.5	40,795	7,395	48,190	17,348
	0.5	570.0	627.0	I(F)		500 (500)									
					0.5		2	70.0	.47	535.0	183.0	81,590	4,209	85,799	483,906
	0.0	645.0	709.5	F		570.0									
							2	75.0	.50	607.5	255.5	81,590	5,876	87,466	524,796
						645.0									

EXHIBIT 7a

(continued)

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TABLE D-2, I

PROBABILISTIC WORKLOAD CALCULATIONS
EQUIPMENT - LEASED SYSTEM

DEVICE IDENTIFICATION: _____

1	2	3a	3b	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PRCB LEVEL	CHARGE-ABLE USE TIME	OPERA-TIONAL USE TIME	COMP SYS.	WL PROB BY SUBSEG-MENT	UNIFORM COST SUBSEG-MENT	NO. OF SYS.	SUBSEG-MENT TIME INCR.	WORKLOAD PROB BY SUBSEG-MENT	AVG. C.U.T. FOR SUB-SEGMENT	EXTRA USE CHARGE-ABLE TIME	BASIC MO. USE COST $40,795/ MONTH	EXTRA MO. USE COST $23/HR.	TOTAL MO. COST	EXP. TOTAL COST/ YEAR
4	1.0	660.0	726.0	F		660.0									
					0.5		2	100.0	0.5	710.0	358.0	81,590	8,234	89,824	538,944
	0.5	760.0	836.0	F		760.0									
					0.5		2	100.0	0.5	810.0	458.0	81,590	10,534	92,124	552,744
	0.0	860.0	946.0	F		860.0									
5	1.0	760.0	836.0	F		760.0									
					0.5		2	110.0	0.5	815.0	463.0	81,590	10,649	92,239	553,434
	0.5	870.0	957.0	F		870.0									
					0.5		2	110.0	0.5	925.0	573.0	81,590	13,179	94,769	568,614
	0.0	980.0	1078.0	F		980.0									

EXHIBIT 7a

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INSTRUCTIONS FOR TABLE D-2, II

PROBABILISTIC WORKLOAD CALCULATIONS

(See Exhibit 7b (Table), This Attachment)

II. MAINTENANCE - LEASED SYSTEM

Columns 1-2: Same titles and instructions as for Table D-2, I.

Column 3 - Staffing Hours: Enter the product of 4/3 and the O.U.T. (Table D-2, I, Column 3b). The factor 4/3 converts O.U.T. to Staffing Hours.

Columns 4-10: Same title and instructions as for Table D-2,I, except that C.U.T. should be replaced by Staffing Hours (S.H.).

Column 11 - Extra Use O.U.T.: Multiply the difference between the Average Staffing Hours for Subsegment (Column 10) and the basic maintenance Staffing time for all systems proposed by the fraction 3/4 and enter the product in Column 11. The factor 3/4 converts staffing hours to O.U.T. for determining On-Call Maintenance charges if applicable.

Column 12 - Basic Monthly Maintenance Costs: Enter the Basic Monthly Maintenance Cost if not included in the Basic Monthly Lease Cost of the equipment.

Column 13 - Number of Calls Per Year: Enter an estimate of the number of calls* per year.

Column 14 - Extra Use Cost Per Year: Enter the product of the number of calls per year (Column 11) and the service charge per call.

Column 15 - Expected Total Cost Per Year: Multiply the Basic Monthly Maintenance Cost (Column 12) by 12 to convert to a yearly cost. Add this to the Extra Use Cost per year (Column 14) and multiply the sum by the Workload Probability by Subsegment (Column 9). Enter the result in this column and in the appropriate place in Table D-4, Expected Cost Summary.

*Refer to Maintenance Formulas, Pages 20 and 21.

ON-SITE MAINTENANCE

(COMPUTER SYSTEM(S) AND REMOTE DEVICES)

The following formula with its computations and explanations will be provided for purchased equipment for each year of the five year system life. If applicable, this formula may also be used to compute on-site maintenance charges for leased equipments.

FORMULA: $X = 12(A+B)$, where

X = Total yearly charge to meet mandatory requirements for "on-site" maintenance, which has been defined to be 8 hours/day, 5 days/week.

A = Basic Monthly maintenance charge for the vendor's principal period of maintenance.

B = Extra charges to provide "on-site" maintenance during the vendor's principal period of maintenance.

NOTE: If multiple systems are proposed for incremental installation, the formula will be modified to reflect the proper installation month (e.g., if a second increment is to be installed in the ninth month the formula[1] would be: $X = 4(A+B)$).

This formula is applicable to Tables D-2, II and D-2, III.

If this formula is not used, explain in detail the computational method used.

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[1] For that increment.

ON-CALL MAINTENANCE

(COMPUTER SYSTEM(S) AND REMOTE DEVICES)

The following formula will be used in computing "on-call" maintenance charges for EDPE including remotes:

FORMULA: Cost of Maintenance/Year = $12 \frac{J}{100}$ (X) (I)

J = 3 (the estimated number of machine failures per 100 CPU operational use hours that require maintenance.)

X = Total number of operational use hours required in excess of 127.5 operational use hours to accomplish the remainder of the workload.

NOTE: Round up to nearest integer.

I = Service charge for unscheduled maintenance calls.

For this analysis, the Air Force will assume that approximately four staffing hours are required to generate three operational use hours. Hence, one personnel staffing shift of 170.0 hours generates a shift of 127.5 operational use hours.

The calculations will be based upon 21.2 working days per month.

This formula is applicable to Table D-2, II and D-2, III.

If this formula is not used explain in detail the computational method used.

TABLE D-2, II

PROBABILISTIC WORKLOAD CALCULATIONS
MAINTENANCE - LEASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF-ING HOURS	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUB-SEGMENT	AVG. STAFFING HOURS FOR SUB-SEGMENT	EXTRA USE OPER-TIONAL USE TIME*	BASIC MONTHLY MAINT. COST	NO. OF CALLS PER YEAR	EXTRA USE COST/YR. (I=$57)	EXPEC-TED TOT. COST/ YEAR
1	1.0	241.9	I		241.9									
				0.5		1	36.7	0.5	260.3	63.2	-	23	1,311	656
	0.5	278.6			278.6									
				0.5		1	36.6	0.5	296.9	90.7	-	33	1,881	941
	0.0	315.2			315.2									
2	1.0	483.9	I		483.9									
				0.5		1	73.3	0.5	520.5	258.4	-	93	5,301	2,651
	0.5	557.2			557.2									
				0.5		1	73.3	0.5	593.8	313.4	-	113	6,441	3,221
	0.0	630.5			630.5									
3	1.0	725.8	I		725.8									
				0.5		1	7.4	.03	729.5	415.1	-	150	8,550	257
	0.5	835.8	I(F)		733.2									
				0.5		2	102.6	.47	784.5	324.4	-	117	6,669	3,134
	0.0	945.7	F		835.8									
						2	109.9	0.5	890.7	404.0	-	146	8,322	4,161
					945.7									

* In this example, the basic staffing period was assumed to be 176.0 hours.

EXHIBIT 7b (continued)

TABLE D-2, II

PROBABILISTIC WORKLOAD CALCULATIONS
MAINTENANCE - LEASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF -ING HOURS	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUBSEG- MENTS	NO. OF SYS.	SUB- SEGMENT TIME INCR.	WORKLOAD PROB. BY SUB- SEGMENT	AVG. STAFFING HOURS FOR SUB- SEGMENT	EXTRA USE OPER'L USE TIME*	BASIC MONTHLY MAINT. COST	NO. OF CALLS PER YEAR	EXTRA USE COST PER YEAR (I=$57)	EXPEC- TED TOT. COST/ YEAR
4	1.0	967.8	F		967.8									
				0.5		2	146.6	0.5	1,041.1	516.8	-	186	10,602	5,301
	0.5	1,114.4			1,114.4									
				0.5		2	146.6	0.5	1,187.7	626.8	-	226	12,882	6,441
	0.0	1,261.0			1,261.0									
5	1.0	1,114.4	F		1,114.4									
				0.5		2	161.6	0.5	1,195.3	632.5	-	228	12,996	6,498
	0.5	1,276.0			1,276.0									
				0.5		2	161.3	0.5	1,356.7	753.5	-	272	15,504	7,752
	0.0	1,437.3			1,437.3									

* In this example, the basic staffing period was assumed to be 176.0 hours.

EXHIBIT 7b

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INSTRUCTIONS FOR TABLE D-2, III

PROBABILISTIC WORKLOAD CALCULATIONS

(See Exhibit 7c (Table), This Attachment)

III. MAINTENANCE - PURCHASED SYSTEM

Columns 1-15: Same titles and instructions as for Table D-2, II. Refer to Maintenance Formulas, pages 20 and 21.

TABLE D-2, III

PROBABILISTIC WORKLOAD CALCULATIONS
MAINTENANCE - PURCHASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF -ING HOURS	COMP. SYS.	WL PROB BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB.BY SUB-SEGMENT	AVG. STAFFING HRS. FOR SUB-SEGMENT	EXTRA USE OPER'L USE TIME*	BASIC MONTHLY MAINT. COST X=$9,273	NO.OF CALLS PER YEAR	EXTRA USE COST PER YR. (I=$57)	EXPEC-TED TOTAL COST/ YEAR
1	1.0	241.9	I		241.9									
				0.5		1	36.7	0.5	260.3	63.2	9,723	23	1,311	58,994
	0.5	278.6			278.6									
				0.5		1	36.6	0.5	296.9	90.7	9,723	33	1,981	59,279
	0.0	315.2			315.2									
2	1.0	483.9	I		483.9									
				0.5		1	73.3	0.5	520.5	258.4	9,723	93	5,301	60,989
	0.5	557.2			557.2									
				0.5		1	73.3	0.5	593.8	313.4	9,723	113	6,441	61,559
	0.0	630.5			630.5									
3	1.0	725.8	I		725.8									
				0.5		1	7.4	.03	729.5	415.1	9,723	150	8,550	3,757
	0.5	835.8	I(F)		733.2									
				0.5		2	102.6	.47	784.5	324.4	19,446	117	669	109,990
	0.0	945.7	F		835.8									
						2	109.9	.50	890.7	404.0	19,446	146	8,322	120,837
					945.7									

* In this example, the basic staffing period was assumed to be 176.0 hours.

EXHIBIT 7c (continued)

TABLE D-2, III

PROBABILISTIC WORKLOAD CALCULATIONS

MAINTENANCE - PURCHASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF -ING HOURS	COMP. SYS.	WL. PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUB-SEGMENT	AVG. STAFFING HRS. FOR SUB-SEGMENT	EXTRA USE OPER'L USE TIME*	BASIC MONTHLY MAINT. COST X=$9,273	NO. OF CALLS PER YEAR	EXTRA USE COST /YR. (I=$57)	EXPEC-TED TOTAL COST/ YEAR
4	1.0	967.8	F		967.8									
				0.5		2	146.6	0.5	1,041.1	516.8	19,446	186	10,602	121,977
	0.5	1,114.4			1,114.4									
				0.5		2	146.6	0.5	1,187.7	626.8	19,446	226	12,882	123,117
	0.0	1,261.0			1,261.0									
5	1.0	1,114.4	F		1,114.4									
				0.5		2	161.6	0.5	1,195.3	632.5	19,446	228	12,996	123,174
	0.5	1,276.0			1,276.0									
				0.5		2	161.3	0.5	1,356.7	753.5	19,446	272	15,504	124,428
	0.0	1,437.3			1,437.3									

* In this example, the basic staffing period was assumed to be 176.0 hours.

UTILITIES (POWER AND AIR CONDITIONING)

FORMULA: Cost of Utilities/Year = 12 (4/3) (Y) (F) ($.0125).

Y = Number of operational use hours required to perform the workload.

F = Number of kilowatts (Kw) required.

The value of F is the sum of the number of Kw necessary to drive and cool the equipment. To convert BTU's to Kw use the factor

$$\frac{1 \text{ Kw}}{10{,}000 \text{ BTU}}$$

Assuming that the ratio of staffing hours to operational use hours is 4/3, then 170.0 manning hours corresponds to 127.5 operational use hours.

This formula is applicable to Table D-2, IV.

If the formula is not used, explain in detail your computational method to be considered. A constant charge of $.0125 per Kw-Hr must be applied in any utilities computation.

INSTRUCTIONS FOR TABLE D-2, IV

PROBABILISTIC WORKLOAD CALCULATIONS

(See Exhibit 7d (Table), This Attachment)

IV. UTILITIES - LEASED AND PURCHASED SYSTEM(S)

Columns 1-3b: Same titles and instructions as for Table D-2, I.

Columns 4-10: Same titles and instructions as for Table D-2, I, with C.U.T. from Column 3a replaced by O.U.T. from Column 3b.

NOTE: Since utilities (power and air conditioning) are usually given as uniform hourly costs, no discontinuities will exist due to shift or system transition. Hence Columns 3b and 6 will have the same values, and Columns 5 and 9 will also have the same values.

Column 11 - Basic Utilities Cost Per Month: Enter the product of the average O.U.T. for each subsegment (Column 10), the conversion factor 4/3 (converts O.U.T. to Staffing Hours), the sum of the kilowatt-hours needed to drive and to cool the equipment, and the specified charge per kilowatt-hour (a constant charge of $0.0125 per kw-hour will be applied).

Column 12 - Total Expected Utilities Cost Per Year: Enter the product of the Basic Utilities Cost per Month (Column 11), the number of months in a year (i.e., 12), and the probability that the cost in question will be incurred (i.e., the workload probability by subsegment in Column 9).* Also enter the result in the appropriate places in the Expected Cost Summary Tables (D-4 and D-5).

* Refer to Utilities Formula, Page 27.

TABLE D-2, IV

PROBABILISTIC WORKLOAD CALCULATIONS
UTILITIES - LEASED AND PURCHASED SYSTEM

1	2	3a	3b	4	5	6	7	8	9	10	11	12
OP'L YR.	WL PROB. LEVEL	CHARGE-ABLE USE TIME	OPERA-TIONAL USE TIME	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUB-SEGMENTS	NO. OF SYS	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUB-SEGMENT	AVG. OPER'L USE TIME FOR SUB-SEGMENT	BASIC UTILITY COST/ MONTH F=71.9 Kw	TOTAL EXPECTED UTILITY COST/YEAR
1	1.0	165.0	181.5	I		181.5						
					0.5		1	27.5	0.5	195.3	234.0	1,404
	0.5	190.0	209.0			209.0						
					0.5		1	27.5	0.5	222.8	267.0	1,602
	0.0	215.0	236.5			236.5						
2	1.0	330.0	363.0	I		363.0						
					0.5		1	55.0	0.5	390.5	467.8	2,807
	0.5	380.0	418.0			418.0						
					0.5		1	55.0	0.5	445.5	533.7	3,202
	0.0	430.0	473.0			473.0						
3	1.0	495.0	544.5	I		544.5						
					0.5		1-2	82.5	0.5	585.8	701.8	4,211
	0.5	570.0	627.0	I(F)		627.0						
					0.5		2	82.5	0.5	668.3	800.6	4,804
	0.0	645.0	709.5	F		709.5						

EXHIBIT 7d (continued)

TABLE D-2, IV

PROBABILISTIC WORKLOAD CALCULATIONS
UTILITIES - LEASED AND PURCHASED SYSTEM

1	2	3a	3b	4	5	6	7	8	9	10	11	12
OP'L YR.	WL PROB. LEVEL	CHARGE-ABLE USE TIME	OPERA-TIONAL USE TIME	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUB-SEGMENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUB-SEGMENT	AVG. OPER'L USE TIME FOR SUB-SEGMENT	BASIC UTILITY COST/MO. F=71.9 kw	TOTAL EXPECTED UTILITY COST/YR.
4	1.0	660.0	726.0	F		726.0						
					0.5		2	110.0	0.5	781.0	935.6	5,614
	0.5	760.0	836.0			836.0						
					0.5		2	110.0	0.5	891.0	1,067.0	6,402
	0.0	860.0	946.0			946.0						
5	1.0	760.0	836.0	F		836.0						
					0.5		2	121.0	0.5	896.5	1,074.3	6,446
	0.5	870.0	957.0			957.0						
					0.5		2	121.0	0.5	1,017.5	1,219.3	7,316
	0.0	980.0	1,078.0			1,078.0						

EXHIBIT 7d

PERSONNEL

COMPUTER CENTER

The personnel costs will include the cost of personnel required to man the computer system on all shifts of operation. Remote operator personnel costs will not be considered. NOTE: If the systems are proposed for incremental installation, the formula will be modified to reflect the proper personnel charges for each increment.

FORMULA: Cost of Personnel/Year = $A(B_1) + A(B_2)\left(\frac{X}{127.5}\right)$

A = Annual cost of computer operator ($8,470 per annum) based upon a staffing shift of 170.0 hours per month.

B_1 = Number of computer operator personnel required during the prime shift.

B_2 = Number of computer operator personnel required after the prime shift.

X = Number of operational use hours required in excess of 127.5 operational use hours to accomplish the workload.

For this analysis, the 127.5 operational use hours are derived from the number of hours available monthly in a personnel staffing shift of 170.0 hours.

This formula is applicable to Table D-2, V.

If a different method of computing personnel costs is used, or any different factors are used, submit substantiating data.

INSTRUCTIONS FOR TABLE D-2, V

PROBABILISTIC WORKLOAD CALCULATIONS

(See Exhibit 7e (Table), This Attachment)

V. PERSONNEL - LEASED AND PURCHASED SYSTEM(S)

Columns 1-10: Same titles and instructions as Table D-2, II.

Column 11 - Extra Chargeable Staffing Hours: Enter the extra staffing hours per month (subtract from Column 10 the product of Column 7 and the basic manning period).

Column 12 - Basic Monthly Staffing Cost: Enter the product of the number of computer center personnel per shift per system, the number of systems (Column 7), and the monthly cost per operator (divide annual rate given in this RFP* by 12).

Column 13 - Extra Monthly Staffing Cost: Enter the product of the number of computer center personnel per shift per system during extra (non-prime shift) staffing hours, the number of computer systems (Column 7), the monthly cost per operator, and the fraction obtained by dividing the extra staffing hours (Column 11) by the basic shift staffing hours.*

Column 14 - Total Monthly Staffing Cost: Enter the sum of the Basic Monthly Staffing Cost (Column 12) and the Extra Monthly Staffing Cost (Column 13).*

Column 15 - Expected Total Cost Per Year: Enter the product of the Total Staffing Cost Per Month (Column 14), the number of months in a year (i.e., 12), and the probability that the cost in question will be incurred (i.e., the workload probability of the subsegment in Column 9). The expected total costs should be added for each operational year and entered in the appropriate place in Tables D-4 and D-5, Expected Cost Summary.

*Refer to Personnel Formula, Page 31.

TABLE D-2, V

PROBABILISTIC WORKLOAD CALCULATIONS
PERSONNEL - LEASED AND PURCHASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF-ING HOURS	COMP. SYS.	WL. PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUBSEG-MENT TIME INCR.	WORKLOAD PROB. BY SUBSEG-MENT	AVG. STAFFING HOURS FOR SUB-SEGMENT	EXTRA CHG. STAFFING HOURS*	BASIC MONTHLY STAFF-ING COST	EXTRA MONTHLY STAFF-ING COST	TOTAL MONTHLY STAFF-ING COST	EXPEC-TED TOT COST/ YEAR
1	1.0	241.9	I		241.9									
				0.5		1	36.7	0.5	260.3	84.3	2,118	1,014	3,132	18,792
	0.5	278.6			278.6									
				0.5		1	36.6	0.5	296.9	120.9	2,118	1,455	3,573	21,438
	0.0	315.2			315.2									
2	1.0	483.9	I		483.9									
				0.5		1	73.3	0.5	520.5	344.5	2,118	4,146	6,264	37,584
	0.5	557.2			557.2									
				0.5		1	73.3	0.5	593.8	417.8	2,118	5,028	7,146	42,876
	0.0	630.5			630.5									
3	1.0	725.8	I		725.8									
				0.5		1	7.4	.03	729.5	553.5	2,118	6,661	8,779	3,160
	0.5	835.8	I(F)		733.2									
				0.5		2	102.6	.47	784.5	432.5	4,235	10,407	14,642	82,581
	0.0	945.7	F		835.8									
						2	109.9	.50	890.7	538.7	4,235	12,962	17,197	103,182
					945.7									

* In this example, the basic staffing period was assumed to be 176.0 hours.

EXHIBIT 7e (continued)

TABLE D-2, V

PROBABILISTIC WORKLOAD CALCULATIONS
PERSONNEL - LEASED AND PURCHASED SYSTEM

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	STAFF-ING HOURS	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS	SUBSEG-MENT TIME INCR.	WORKLOAD PROB. BY SUB-SEGMENT	AVG. STAFFING HOURS FOR SUB-SEGMENT	EXTRA CHG. STAFF-ING HOURS*	BASIC MONTHLY STAFF-ING COST	EXTRA MONTHLY STAFF-ING COST	TOTAL MONTHLY STAFF-ING COST	EXPEC-TED TOTAL COST/ YEAR
4	1.0	967.8	F		967.8									
				0.5		2	146.6	0.5	1,041.1	689.1	4,235	16,576	20,811	124,866
	0.5	1,114.4			1,114.4									
				0.5		2	146.6	0.5	1,187.7	835.7	4,235	20,109	24,344	146,064
	0.0	1,261.0			1,261.0									
5	1.0	1,114.4	F		1,114.4									
				0.5		2	161.6	0.5	1,195.3	843.3	4,235	20,298	24,533	147,198
	0.5	1,276.0			1,276.0									
				0.5		2	161.3	0.5	1,356.7	1,004.7	4,235	24,183	28,418	170,508
	0.0	1,437.3			1,437.3									

* In this example, the basic staffing period was assumed to be 176.0 hours.

EXHIBIT 7e (continued)

CONDITIONAL PROBABILITY FOR PURCHASE

The probability of purchasing a system in a given operational year is a conditional probability since it depends on whether the system had been purchased in the previous years and on the probability of needing it during the year in question.

FORMULA: $P_i = \left(1 - \sum_{j<i} P_j\right) Q_i$

where P_i = the conditional probability of purchasing the systen during operational year i (Column 11).

$\sum_{j<i} P_j$ = the probability that the system was purchased during the years preceding year i; i.e., the years 1 through (i-1) for the system in question. for the system in question.

$\left(1 - \sum_{j<i} P_j\right)$ = the probability that the system was not purchased during the years preceding year i.

Q_i = the probability that the system will be needed in operational year i (Column 10).

NOTE: $P_o = 0$.

This formula is applicable to Table D-3.

INSTRUCTIONS FOR TABLE D-3

PROBABILISTIC WORKLOAD CALCULATIONS
EQUIPMENT PURCHASE AND TRANSPORTATION

(See Exhibit 8 (Table), This Attachment)

Columns 1-5: Same titles and instructions as Table D-2, I.

Column 6 - Uniform Cost Subsegments: Enter the value of Operational Use Time that indicates when an additional computer system will have to be installed. The time inserted will be the maximum Operational Use Time (550 Hours) assumed to be available from the proposed system(s).

Columns 7-9: Same titles and instructions as Table D-2, I.

Column 10 - Probability of Having to Purchase a New System: Enter the probability that a new system will have to be purchased in a given operational year. The probability that a new system may have to be installed in a given year is the sum of the probabilities that the O.U.T. may exceed during that year the time available from the system(s) already installed.

Column 11 - Conditional Probability for Purchase: Enter the conditional probability of purchasing a primary processing system for each operational year. Refer to Conditional Probability Formula, Page 34.

Column 12 - Equipment Purchase Costs: Enter the total purchase costs for all the equipments in the system proposed (from Table D-1, total Column 8).

Column 13 - Transportation Costs: Enter the transportation costs associated with the delivery and installation of the system(s) in question.

Column 14 - Total Expected Transportation Costs: Enter the product of the conditional probability for purchase (Column 11) and the Transportation Costs (Column 13).

Column 15 - Total Expected Equipment Costs: Enter the product of the conditional probability for purchase (Column 11) and the Equipment Purchase Costs (Column 12).

TABLE D-3

PROBABILISTIC WORKLOAD CALCULATIONS
EQUIPMENT PURCHASE AND TRANSPORTATION

1	2	3a	3b	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	CHARGE-ABLE USE TIME	OPERA-TIONAL USE TIME	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUBSEG-MENT	PROB. OF HAVING TO PUR. NEW SYS.	COND. PROB. FOR PUR.	EQUIP-MENT PURCHASE COSTS	TRANS-PORTA-TION COSTS	TOT.EX-PECTED TRANSP. COSTS	TOTAL EXPECTED EQUIP. COSTS
1	1.0	165.0	181.5	I		181.5				1.00	1.00	3,079,675	8,000	8,000	3,079,675
					0.5		1	27.5	0.5						
	0.5	190.0	209.0			209.0									
					0.5		1	27.5	0.5						
	0.0	215.0	236.5			236.5									
2	1.0	330.0	363.0	I		363.0				0	0	-	-	-	-
					0.5		1	55.0	0.5						
	0.5	380.0	418.0			418.0									
					0.5		1	55.0	0.5						
	0.0	430.0	473.0			473.0									
3	1.0	495.0	544.5	I		544.5				0.97	0.97	3,079,675	8,000	7,760	2,987,285
					0.5		1	5.5	.03						
	0.5	570.0	627.0	I(F)		550.0									
					0.5		2	77.0	.47						
	0.0	645.0	709.5	F		627.0									
							2	82.5	0.5						
						709.5									

EXHIBIT 8 (continued)

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TABLE D-3

PROBABILISTIC WORKLOAD CALCULATIONS
EQUIPMENT PURCHASE AND TRANSPORTATION

1	2	3a	3b	4	5	6	7	8	9	10	11	12	13	14	15
OP'L YR.	WL PROB. LEVEL	CHARGE-ABLE USE TIME	OPERA-TIONAL USE TIME	COMP. SYS.	WL PROB. BY SEGMENT	UNIFORM COST SUBSEG-MENTS	NO. OF SYS.	SUB-SEGMENT TIME INCR.	WORKLOAD PROB. BY SUBSEG-MENT	PROB. OF HAVING TO PUR. NEW SYS.	COND. PROB. FOR PUR.	EQUIP-MENT PURCHASE COSTS	TRANS-PORTA-TION COSTS	TOT. EX-PECTED TRANSP. COSTS	TOTAL EXPECTED EQUIP. COSTS
4	1.0	660.0	726.0	F		726.0				1.00	.03	3,079,675	8,000	240	92,390
					0.5		2	110.0	0.5						
	0.5	760.0	836.0			836.0									-
					0.5		2	110.0	0.5						
	0.0	860.0	946.0			946.0									
5	1.0	760.0	836.0	F		836.0									
					0.5		2	121.0	0.5	0	0	-	-	-	-
	0.5	870.0	957.0			957.0									
					0.5		2	121.0	0.5						
	0.0	980.0	1,078.0			1,078.0									

EXHIBIT 8

INSTRUCTIONS FOR TABLE D-4

EXPECTED COST SUMMARY - LEASED SYSTEM

(See Exhibit 9 (Table), This Attachment)

Line 1 - Equipment Lease Cost: For each operational year enter the total expected lease cost for each group of computer components that were treated collectively in Table D-2, I (Column 15).

Line 2 - Maintenance: Enter the total charges for maintenance for leased equipment for each operational year by summing the appropriate total costs in Column 15 of Table D-2, II.

Line 3 - Utilities: Enter the total charges for electrical consumption for each operational year to operate the proposed equipments, computed as above, from Column 12 of Table D-2, IV.

Line 4 - Personnel: Enter the total charges for operating personnel for each operational year, computed as above, from Column 15, Table D-2, V.

Line 5 - Transportation: Enter the total expected transportation costs for each operational year from Column 14, Table D-3.

Line 6 - Purchase Only Items: Enter the charges for purchases only items from Table D-1.

Line 7 - Other Recurring: Enter all other associated recurring charges not included above (provide an explanatory note in the Cost Questionnaire).

Line 8 - Other Nonrecurring: Enter all other associated nonrecurring charges not included above (provide an explanatory note in the Cost Questionnaire).

Line 9 - Desirable Features: For each desirable feature that is being provided in the proposed system, identify the feature on a separate line and indicate the cost where identifiable for each operational year.

Line 10 - Total: For each operational year, enter the sum of all the preceding lines.

TABLE D-4

EXPECTED COST SUMMARY
LEASED SYSTEM

	COST ELEMENTS	OPERATIONAL YEAR 1	OPERATIONAL YEAR 2	OPERATIONAL YEAR 3	OPERATIONAL YEAR 4	OPERATIONAL YEAR 5
1	Equipment	493,741	545,844	1,026,050	1,091,688	1,122,048
2	Maintenance	1,597	5,872	7,552	11,742	14,250
3	Utilities	3,006	6,009	9,015	12,016	13,762
4	Personnel	37,582	80,422	188,964	271,124	317,706
5	Transportation	8,000	-	7,760	240	-
6	Purchase Only Items	0	0	0	0	0
7	Other Recurring Charges					
8	Other Nonrecurring Charges					
9	Desirable Features					
10	TOTAL	543,926	638,147	1,239,341	1,386,810	1,467,766
11*	Discount Factor IAW DoDI 7041.3	0.954	0.867	0.788	0.717	0.652
12*	Present Value	518,905	553,273	976,601	994,343	956,983

* Not included in original RFP.

EXHIBIT 9

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INSTRUCTIONS FOR TABLE D-5

EXPECTED COST SUMMARY - SYSTEM PURCHASE

(See Exhibit 10 (Table), This Attachment)

Line 1 - Equipment: Enter the total expected purchase price of the proposed system(s) from column 15, Table D-3.

Line 2 - Maintenance: Enter the total charges for maintenance for system purchase for each operational year by summing the appropriate total expected costs in Column 15 of Table D-2, III for each year.

Line 3 - Utilities: Enter the figures from column 12 of Table D-2, IV.

Line 4 - Personnel: Enter the figures from column 15 of Table D-2, V.

Line 5 - Transportation: Enter the figures from column 14, Table D-3.

Line 6 - Other Recurring Charges: Enter the figures from column 7 of Table D-4.

Line 7 - Other Nonrecurring Charges - Enter the figures from column 8 of Table D-4.

Line 8 - Desirable Features: For each desirable feature that is being provided in the proposed system, identify the feature on a separate line and indicate the cost where identifiable for each operational year.

Line 9 - Total: For each operational year, enter the sum of all the preceding lines.

TABLE D-5

EXPECTED COST SUMMARY
SYSTEM PURCHASE

	COST ELEMENTS	OPERATIONAL YEAR 1	OPERATIONAL YEAR 2	OPERATIONAL YEAR 3	OPERATIONAL YEAR 4	OPERATIONAL YEAR 5
1	Equipment	3,079,675	-	2,987,285	92,390	-
2	Maintenance	118,273	122,548	234,584	245,094	247,602
3	Utilities	3,006	6,009	9,015	12,016	13,762
4	Personnel	37,582	80,422	188,964	271,124	317,706
5	Transportation	8,000	-	7,760	240	-
6	Other Recurring Charges					
7	Other nonrecurring Charges					
8	Desirable Features					
9	TOTAL	3,246,536	208,979	3,427,608	620,864	579,070
10*	Discount Factor IAW DoDI 7041.3	0.954	0.867	0.788	0.717	0.652
11*	Present Value	3,097,195	181,185	2,700,955	445,159	377,554

* Not included in original RFP.

EXHIBIT 10

TABLE D-6

COST QUESTIONNAIRE

Answer each of the following questions regarding costs.

1. Basic and Extra Use Costs:

a. State the number of hours per month which constitute the basic shift and explain in detail, how operational use time is measured.

b. If extra shift use of one component or one category of component creates costs associated with other components or categories of components, explain the details of such costs.

2. Overall System Costs: Based upon the requirements specified in the RFP, state the total expected monthly lease cost and total expected purchase cost for the proposed system(s). Applicable Tables D-1, D-2, and D-3 should be completed to show the breakout of such costs into the following categories of equipment: Central Processor, Input/Output, IAS, Remotes, and Others.

3. Transportation Costs: State the total cost of transporting the proposed equipment from your manufacturing facility to the user's site. Provide shipping weights for the configuration proposed, the location of the manufacturing facility, and freight rates assumed. Indicate any special shipping requirements.

4. Installation Costs: State the cost of installing the proposed equipment considering unique or special facility requirements not covered in Chapter 3, Attachment II.

5. Maintenance Proposed:

a. Explain your maintenance contract terms, conditions, and prices, as they relate to the proposed equipment. If applicable, provide the specific Air Force contract reference covering the proposed maintenance plan for this RFP.

b. State the charges, if any, to meet the mandatory maintenance requirements of this RFP. (Reference Paragraph 5-2-5c, Chapter 5 of Attachment II.) Maintenance charges must be reflected in the cost tables, as applicable.

TABLE D-6 (continued)

c. If your maintenance charges are based on equipment usage, explain how these charges are computed. These charges, if applicable, must be reflected in the cost tables.

d. State the charges for the following calls:

	Leased System	Purchased System
(1) Hourly cost outside prime shift	_____	_____
(2) Minimum charge for a maintenance call	_____	_____
(3) Weekend, Holiday, or other maintenance charges	_____	_____
(4) For what distance will the Air Force be required to pay travel expenses for maintenance engineers, if any, and at what rate per mile?	_____	_____
(5) Estimate the average travel time for the maintenance engineers to respond to remedial maintenance service and the approximate distance they must travel. State if travel time is chargeable	_____	_____
(6) Other Maintenance Charges (explain)	_____	_____

e. Are there any charges for on-site maintenance when a holiday falls in the five-day week? If yes, state the charges for lease and purchase contracts.

f. Power Consumption. State your estimate of electrical consumption in kilowatts for the proposed system and the power supply requirements in KVA necessary to operate the system.

TABLE D-6 (continued)

g. Operating Personnel. State your estimate of the number of personnel recommended to operate your proposed configuration(s). (This number does not include clerical and supervisory personnel.)

h. Air Conditioning. Under normal operating conditions, how many BTUs of heat are generated each hour by this system?

*

7. Cost of Metering Devices: In the event additional charges are involved for incorporating the metering devices and/or meters, provide a detailed breakdown of such costs.

8. Cost of Vendor's Support: Specify the portion of the mandatory requirements outlined in Vendor Support, reference Paragraph 5-2-5, Chapter 5, Attachment II, which will be furnished by the contractor without charge. Moreover, any proposed additional cost for personnel furnished as an additional expense, or any extra charges anticipated in connection with these requirements should be indicated in detail including cost variations, if any, for the several methods of acquisition (purchase, lease with option to buy, etc.).

9. Documentation: Indicate the number of publications furnished at no cost for each category listed below. If none, write "None." An entry should be made for each category. Identify and describe briefly rates or costs for one copy of any of the listed categories or publications below, if such cost is applicable.

a. Manuals:	Number	Cost
(1) Maintenance	_____	_____
(2) Systems and Methods	_____	_____
(3) Programming	_____	_____
(4) Training	_____	_____
(5) Installation Planning	_____	_____
(6) Operator	_____	_____
(7) Others (specify)	_____	_____

*No. 6. was not used.

TABLE D-6 (continued)

b. Programming Routine Descriptions:	Number	Cost
(1) COBOL	_____	_____
(2) FORTRAN	_____	_____
(3) Sort/Merge	_____	_____
(4) Assembly System	_____	_____
(5) Executive	_____	_____
(6) Others (specify)	_____	_____
c. Programming Aids:		
(1) Printer Layout	_____	_____
(2) Memory Layout	_____	_____
(3) Coding Sheets	_____	_____
(4) Record Layout	_____	_____
(5) Other (specify)	_____	_____

10. Cost of Supplies: State the per unit cost of various supplies needed for use with the proposed equipment, including cost of magnetic tape reels, control panels, coding sheets, etc. Exclude common cost items such as punched cards or printed forms.

11. Guaranteed Periods for Prices, Terms, and Conditions:

a. State the inclusive periods during which the prices for lease, purchase, maintenance and other services quoted in your proposal will not be increased.

b. State the inclusive periods during which the terms and conditions you propose will be guaranteed for all services, equipment and software offered.

12. Desirable Features: State the costs that will be chargeable to the Air Force for the desirable features stated in Attachment II, Chapter 5, Paragraph 5-3. Specify what items are provided at no charge. Chargeable items must be included in Tables D-4, and D-5, as applicable.

TABLE D-6 (continued)

13. Other Costs: List and define the cost to the Government for any other services (special programs, special maintenance, etc.) required from your company.

14. Purchase Option: Explain your purchase option contract for the proposed configuration.

15. Lease with Purchase Option: Explain your lease with purchase option plan for the proposed configuration.

16. Cost of Expansion Capability: State the Monthly Lease Cost, Purchase Price, and Maintenance Cost for the equipments proposed to meet the expansion requirements stated in Attachment II, Chapter 5, Paragraph 5-2-7. Show the breakout of such costs by component and indicate the number of components required to meet the requirements of the RFP.

17. Field Modifications: State the costs that will be chargeable to the Air Force for any anticipated field modifications of proposed equipments (increased memory, additional disk, etc.) to meet the requirements of the RFP.

18. Describe any other terms, conditions, or features of significance to Air Force concerning the proposal that are not already covered elsewhere in your proposal.

DISCUSSION

In Case 2, it was suggested that a form of bonded warranty would be suitable for ADP/EDP type of equipment. This Case goes beyond that suggestion through the inclusion of a maintenance contract as part of the initial purchase or lease. Through such a device, the government establishes a known limit on part of the maintenance cost. The LCC elements of operating labor and utilities may be checked during the required demonstration.

An element which is missing is the penalty associated with improper estimation of corrective maintenance. It is recommended that such a penalty be included. For instance,*

> The contractor shall perform all scheduled and on-call maintenance for a period of 5 years after the date of equipment installation and acceptance by the Government and will bill the Government at his usual rates for services performed. The Government will pay all annual maintenance charges billed up to and including the amounts shown for maintenance on Table D-2, II or Table D-2, III, whichever is applicable. The Government will not pay for maintenance performed in excess of the amount shown for maintenance on Table D-2, II or Table D-2, III, whichever is applicable. However, the contractor will continue to provide all scheduled and on-call maintenance after the maximum annual billing amount is exceeded.

An LCC element not included is the final cost (or income). No provision is made for the value of the equipment at the end

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*This clause is not an example of an approved contract provision. It is included here only to clarify the recommendation for a penalty clause.

of the proposed 5-year life cycle. Since that cost could be significant for this type of equipment when considering the alternatives of lease or purchase, it is recommended that a residual value estimate be included in the cost comparison. One method of arriving at the residual value would be to require the vendor to state a price for which he would agree to re-purchase the equipment after five years.

The use of probabilities is an important feature of this Case. Rather than assume one level of usage of the equipment, a range of usage levels is considered, with probabilities estimated for different portions of that range. Hence uncertainty about usage is included in the analysis. Costs are computed for operation of the equipment at certain stipulated usage levels. The cost ultimately used in evaluation of proposals is the weighted average LCC at the usage levels considered.

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